Effects of testosterone suppression on biology and performance in Transgender Women

- With special emphasis on muscle mass and strength -

Tommy Lundberg, PhD
How big is the gap in performance?

- World records in Athletics events: Men 10-15% better

- Weightlifting and Powerlifting: Men 45-55% better

- Performance gaps in team sports are difficult to quantify

From world champions to humbling defeat against Under 15s side... World Cup-winning USA women's team suffer 5-2 loss against Dallas academy boys
How big is the gap in *muscle mass and strength*?

**Elite Rugby Players**

- **Anthropometrics and body composition:**
  102 vs. 74 kg  
  186 vs. 169 cm  
  75 vs. 49 kg lean mass  
  40% heavier  
  10% taller  
  50% more lean mass

- **Bench press:**
  110-120 kg male  
  55-60 kg female  
  Up to 100% stronger

- Data in our lab: 30-50% differences in *untrained* men vs. women

Ross Tucker  
Jones et al. 2016  
Morehen et al. 2019  
Hene & Bassett 2013  
Brazier et al. 2018
Muscle strength, size and composition following 12 months of gender-affirming treatment in transgender individuals

Anna Wiik, Tommy R Lundberg, Eric Rullman, Daniel P Andersson, Mats Holmberg, Mirko Mandić, Torkel B Brismar, Olof Dahlqvist Leinhard, Setareh Chanpen, John N Flanagan, Stefan Arver, Thomas Gustafsson

The Journal of Clinical Endocrinology & Metabolism, dgz247, https://doi.org/10.1210/clinem/dgz247

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Design and methods

- 11 Transgender women (TW)
- 12 Transgender men (TM)
- Approved for cross-hormone treatment: $T$ suppression $<1$ nmol/L
- Body and muscle composition
- Lower-limb Muscle strength
- Tissue samples: blood, muscle, fat, skin
- Heart/vessel function
Methods

Isokinetic Dynamometry

Whole-body MRI
MRI: Muscle vs. Fat quantification

Muscle

Fat
CT imaging
Muscle volume decreased 5%
Modest change in radiological attenuation
No change in isometric strength
TW after treatment:
48% stronger
35% larger Quads
compared with CW

Retained ”advantage” for the Transwomen

Isometric torque levels (Nm)

Muscle thigh volume levels (L)
Strength/volume relationship

- **Control women**
- **Transwomen 12 months**

![Graph showing the relationship between strength and muscle volume for control women and transwomen 12 months.](image-url)
Effect of gender-affirming treatment

BASELINE

12 MONTHS TREATMENT

Muscle volume

Strength

Muscle volume

Strength

Transmen

Transwomen
50-70% of the advantage is carried in the height

TW after treatment:
22% stronger
11% larger Quads compared with CW
Individual variation

Delta change in total thigh muscle volume
Results: Body fat - large variation

- Total fat tissue (distal thigh to T9)
- Total abdominal fat
- Abdominal subcutaneous adipose tissue
- Visceral adipose tissue

Change in compartmental fat (%)

- 40% increase

Fat ratio %

- * P = 0.02
- +6% units

Body weight

- +3 kg (P=0.1)
SUMMARY - changes in Transgender women with 12 months treatment

- Lost 5% of muscle volume
- No loss in muscle strength
- Significant "advantage" over control women and transgender men
- Individual variation - some lose more, a few lose almost nothing
- Increased body fat content - but again some individuals resistant to changes
**Results in context of previous literature: agreement across studies**

<table>
<thead>
<tr>
<th>Study</th>
<th>Measure</th>
<th>1 yr</th>
<th>2 yr</th>
<th>3 yr</th>
<th>&quot;Advantage&quot; at 1 yr</th>
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<tbody>
<tr>
<td>Elbers 1999 / Gooren 2004</td>
<td>Thigh area</td>
<td>−9 %</td>
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<td>−12 %</td>
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<td>LBM</td>
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<td>Mueller et al. 2011</td>
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<td>−0.5%</td>
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<tr>
<td>Van Caenegem et al 2015</td>
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<td>−9 %</td>
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</table>

**5% loss**  
**25% advantage**
Extending the time-frame of the suppression period

New steady state

The typical LBM of untrained TW after 1 yr treatment fall within the range of elite female Rugby players
Muscle changes are indeed always greatest in the beginning.

**Modified from Björn Alkner PhD thesis**

**TRANSMEN**

Thigh area 1 and 3 yr T treatment

Muscle loss with bed rest

- 20 days
- 120 days
- 10%
- 15%

Elber et al. 1997
8 year cross-sectional study

Mean Cross-hormone therapy 8 years

Comparison with age- and height-matched male controls

Expected Lean mass difference
- Men: 30%
- Women: 40%
- Transwomen: 25%

Expected Peak torque difference
- Men: 40%
- Women: 30%
- Transwomen: 25%

Lapauw et al. 2008 Bone 43(6)
Monthly rate of muscle loss

- Short-term ULLS: 10%
- Long-term Bed rest: 6.7%
- Short-term VLCD 400 kcal diet: 2.6%
- Gender-affirming treatment: 0.4%
- Long-term Ketogenic diet: 0.2%

High-intensity RE + High protein intake attenuate these losses!
Testosterone does not regulate exercise-induced muscle hypertrophy

- No effect of prior elevation of systemic hormones
- Blocking IGF-1 does not hamper muscle hypertrophy
- No correlation with end-points
- Women and men respond similarly despite large differences in hormone levels

West et al. (2010)
Estrogen has anabolic potential

Myofibrillar protein synthesis (Dieli-Conwright et al., 2009; Pöllänen et al., 2010)

Maintains muscle mass in gonadectomized male mice (Svensson et al. 2010)

"Estrogen improves muscle mass and strength, and increases the collagen content of connective tissues"
Now what would happen in Transgender ATHLETES?
Elite rugby players

- High lean mass - higher starting point
- Greater losses with gender-affirming treatment?
- What happens if all efforts available to maintain muscle mass are put in?

*We simply don’t know!*

The more you have the more you lose?

\[ R = -0.37, \ P = 0.26 \]
OVERALL SUMMARY

▪ Transwomen lose about 5% of muscle mass during 12 months of gender-affirming treatment

▪ There is no evidence of continuous losses from 1 to 3 yrs treatment - rather there are indications of a plateau or a complete stop of losses: new steady-state

▪ Muscle strength does not seem to drop substantially

▪ Retained advantage 20-30% compared with reference women or transmen at baseline

▪ Some individuals are resistant to losses

▪ Some of the advantage resides in the height difference, which will never go away

▪ The potential use of exercise- and nutritional countermeasures to minimize decrements must be considered
Thank you!