Girls with Turner syndrome have normal muscle force but decreased muscle power

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None of the authors have any conflict of interest.

Introduction
Turner syndrome (TS) is associated with decreased bone mineral density and altered bone geometry, which is assumed a risk factor leading to increased fracture rate. Although hypogonadism or SHOX gene haploinsufficiency are the probable causes, the exact mechanism remains unclarified. Particularly, the muscle function as an important determinant of bone strength has not been focused on in TS.

We tested the hypothesis that there is muscle dysfunction in TS.

Secondary aim was to describe the influence of pubertal stage, hormone therapy, fracture history and genotype.

Table 1. Anthropometry characteristics of TS patients.

<table>
<thead>
<tr>
<th>N=60</th>
<th>mean (SD)</th>
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<tbody>
<tr>
<td>Age (year)</td>
<td>13.7 (4.6)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>43.2 (16.3)</td>
</tr>
<tr>
<td>Weight (Z-score)</td>
<td>-0.63 (1.2)** ***</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>142.3 (17.3)</td>
</tr>
<tr>
<td>Height (Z-score)</td>
<td>-1.8 (0.93)**</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>20.3 (4.1)</td>
</tr>
<tr>
<td>BMI (Z-score)</td>
<td>0.44 (0.98)**</td>
</tr>
</tbody>
</table>

The Z-scores were tested for difference from 0 by one-sample T-test. *p<0.05 **p<0.01 ***p<0.001

Patients and Methods
All TS patients consenting to the study and having no other chronic disease were included (60 patients, age 13.7±4.5 years). Age- and weight-specific z-scores of muscle parameters were calculated based on control group of 432 healthy girls.
Leonardo Mechanograph® Ground Reaction Force Platform was used to assess muscle force (F_max) by the multiple one-legged hopping test and muscle power (P_max) by the single two-legged jump test. Muscle functions were related to body weight (F_max/BW) and body mass (P_max/mass), respectively.

Figure 1. F_max (A+B) and F_max/BW (C+D) of TS patients plotted into age- and weight-specific nomograms, respectively.

Results
While F_max and F_max/BW were normal (mean weight-specific Z-scores 0.11±0.77, p=0.27, and 0.046±0.62, p=0.55; Fig. 1), P_max and P_max/mass were decreased in TS (Z-scores -0.93±1.5, p<0.001, and -0.45±0.58, p<0.001; Fig. 2), as compared to healthy controls. The muscle functions were not significantly influenced by pubertal stage, hormone therapy, fracture history nor genotype (linear regression, adjusted for age, weight and height, all p>0.05).

Figure 2. P_max (A+B) and P_max/mass (C+D) of TS patients plotted into age- and weight-specific nomograms, respectively.

Patients with Turner syndrome may have normal muscle force but decreased muscle power.

Figure 3. The influence of karyotype on P_max/mass in TS girls.

The influence of karyotype (mosaic vs. X monosomy) was tested in linear regression model with adjustment for age, weight, weight*2 and height (β=-0.108±0.085, P=0.22). Boxes represent median and interquartile range, lines are maximum and minimum.

Conclusions
F_max as a principal determinant of bone strength is normal in TS. The changes in bone quality and structure in TS are therefore not related to inadequate mechanical loading, but rather represent a primary bone deficit. Decreased P_max may represent a novel indicator of impaired muscle coordination in TS.