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Brief Report

# Ten Minutes Extension Endurance Test in Healthy Inactive vs. Active Male People

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## Abstract

**Purpose:** Intense endurance and strength training mark virtually opposite parts of basic motor skills. Extreme high load physical demands are getting sparer but endurance demands are still present. Therefore, we exposed healthy controls and endurance and strength trained athletes at competition level to a submaximal endurance test of their back muscles' endurance.

**Methods:** In this pilot study 38 healthy male subjects participated: physically inactive controls (C, n=12), endurance trained (ET, n=13), and strength trained subjects (ST, n=13). We asked all participants to finish a ten minutes back muscle endurance test at 50% of their upper body weight. After every completed minute participants were prompted to rate their level of perceived exertion according to the well-established Borg-scale.

**Results:** Maximum holding times were shortest in the ST group (469 ± 142 s; ET 600 ± 0 s; C 600 ± 0 s), but statistical significance could only be proven for ET vs. ST ($p<0.01$). Hedges gs values for comparisons of maximum holding times showed relevant differences among all groups: ET vs. ST 10.64; ET vs. C 2.38; ST vs. C 0.78. Values of perceived exertion increased over time with lowest values for the ET group, except after the first minute. Especially between 180s and 420s ST group showed highest exertion values, but between group differences could not be determined.

**Conclusions:** Static back muscle endurance capacity of strength trained subjects is considerably reduced in comparison to endurance as well as untrained healthy subjects. The results suggest adverse effects of strength-only training when endurance tasks have to be compensated.

**Keywords:** Endurance capacity; Back muscles; Training modalities

## Introduction

To counteract today's inactive lifestyle, recreational sports is becoming increasingly popular, since positive effects on metabolic processes [1], or more generally life satisfaction especially in old age [2] can be identified to name just two examples. Nowadays, there exists a wide range of sports disciplines, whereby every physical activity can ultimately be traced back to the basic motor skills strength, endurance, speed, agility and coordination. Depending on the chosen training modality, the respective training focuses either on several aspects simultaneously or single aspects are particularly emphasized. In particular, strength and endurance are possible isolated individual training goals, while speed, agility and coordination can be regarded as a prerequisite for any type of sports activity in terms of training progress and protection against injury. However, the maintenance or training of these basic skills plays a role not only for athletic activity, but also for everyday life. Here we must

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react appropriately to a wide variety of physical demands. Since extreme strength requirements in everyday life are becoming sparer, particularly endurance training represents an essential part of everyday physical demands. The impact of high training intensities of endurance and strength training was therefore investigated in the present study. For this investigation we exposed inactive control subjects as well as endurance and strength athletes to a ten-minute endurance test of their back muscles at 50% of their upper body weight.

## Materials and Methods

Parts of the data have been published with respect to fatigue-related changes of back-muscle Surface EMG characteristics [3]. Therefore, subject characteristics are identical.

### Subjects

For this study we recruited 38 healthy male participants. Participants consisted of three subgroups: a group of physically inactive people (Control (C), n=12) and two groups of physically active people at competition level (at least four training sessions per week). The two physically active groups practiced either endurance (ET, cycling and triathlon, n=13) or strength training (ST, power lifting, n=13). Participants were informed about the procedure and aim of the study and signed informed consent to voluntary participates in this investigation. The study was approved by the ethics committee of the Friedrich-Schiller University Jena (2020-1844-BO). Details about the study participants are provided in Table 1.

### Methodology

Participants were positioned in a computerized test and training device (CTT Centaur, BfMC, Leipzig, Germany) in standing upright posture. In this device the subjects' lower body is fixed while the upper body maintains freedom of movement. The device is equipped with a harness, positioned over the subjects' shoulder that contains strain gauges for force measurement in frontal and sagittal directions. Additionally the device is equipped with a small feedback monitor in front of the subject. Here a moving target point is displayed that is located in the centre of a crosshair if not net force acts on the harness, i.e. the subject adheres to upright body posture. By tilting the device gravitational forces act on the trunk, enabling defined load levels up to 100% of the subject's Upper Body Weight (UBW) if tilted to horizontal position. For warm up participants completed a set of submaximal flexion and extension tests. Subsequently they were exposed to 50% UBW extension load by tilting them forward at an angle of 30°. For this endurance test we defined a maximum of 600 s as the target time. Participants were requested to maintain their upright position until target time was reached, or until exhaustion (Figure 1). After every completed minute we asked them about their level of perceived exertion by using the 6 to 20 Borg scale [4].

### Statistics

Basically t-tests were applied to test differences of maximum holding times among groups, together with the respective Bonferroni-correction for multiple testing. In addition, effect sizes were calculated to address the relevance of found differences. For this we used Hedges gs as it is particularly suited for small sample sizes [5]. To assess between group differences of the Borg values we applied the non-parametric Kruskal and Wallis test, followed by the respective post hoc tests.

**Table 1:** Participant characteristics.

| | Endurance | Strength | Control |
|---|---|---|---|
| Age [years] | 22.2 ± 2.9 | 23.5 ± 1.8 | 22.1 ± 1.0 |
| Height [cm] | 184 ± 6.5 | 180 ± 5.6 | 184 ± 5.9 |
| Weight [kg] | 72.8 ±.7.0 | 90.3 ± 13.9§§ | 78.9 ±.14.3 |
| BMI [kg/m²] | 21.5 ± 1.3 | 27.7 ± 3.8§§ | 23.1 ±.3.8$ |
| UBW [kg] | 31.7 ± 2.8 | 37.0 ± 4.5§ | 32.7 ± 4.5 |
| UBT [Nm] | 123 ± 12.3 | 134 ± 21.8 | 125 ± 19.5 |

BMI: Body Mass Index; UBW: Upper Body Weight; UBT: Upper Body Torque
§ p < 0.05 vs. endurance; §§ p < 0.01 vs. endurance; $ p < 0.05 vs. strength

**Figure 1:** Subject performing the endurance task at 30° forward tilt (50% of upper body weight). Note the small feedback monitor in front of the subject for control of exact adherence to upright body posture.

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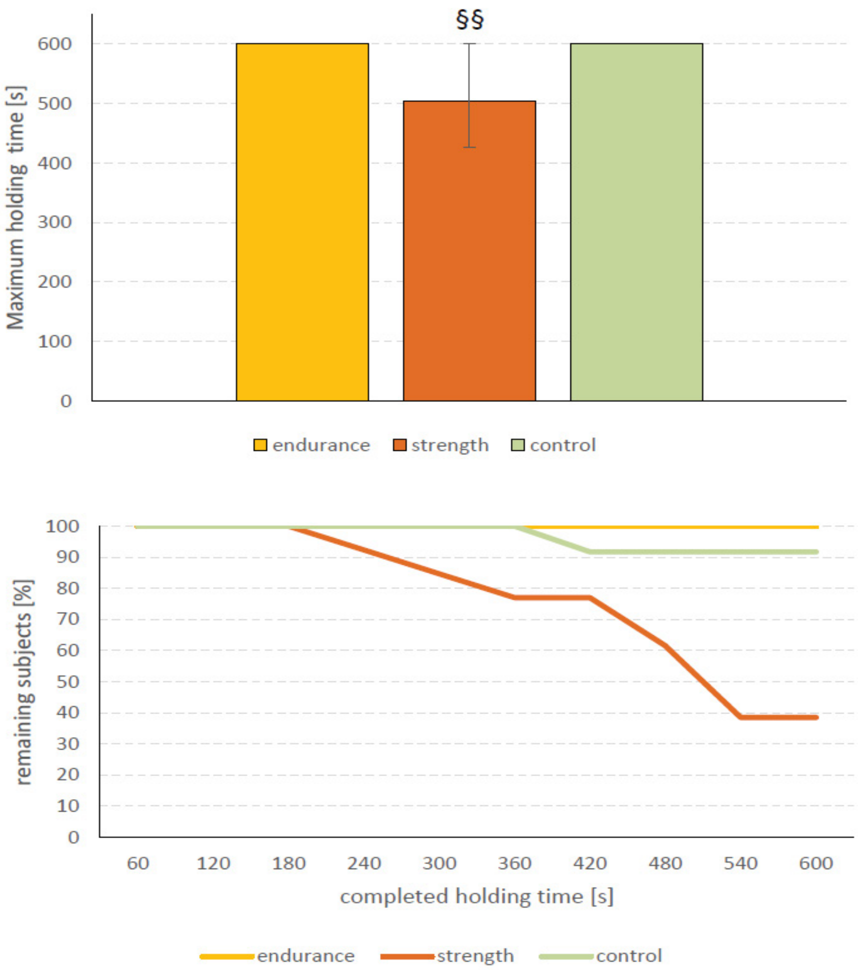


**Figure 2:** Maximum endurance times (upper panel) and remaining subjects (lower panel) for the endurance task. Values are given as mean values ± SD. Statistical differences are indicated.

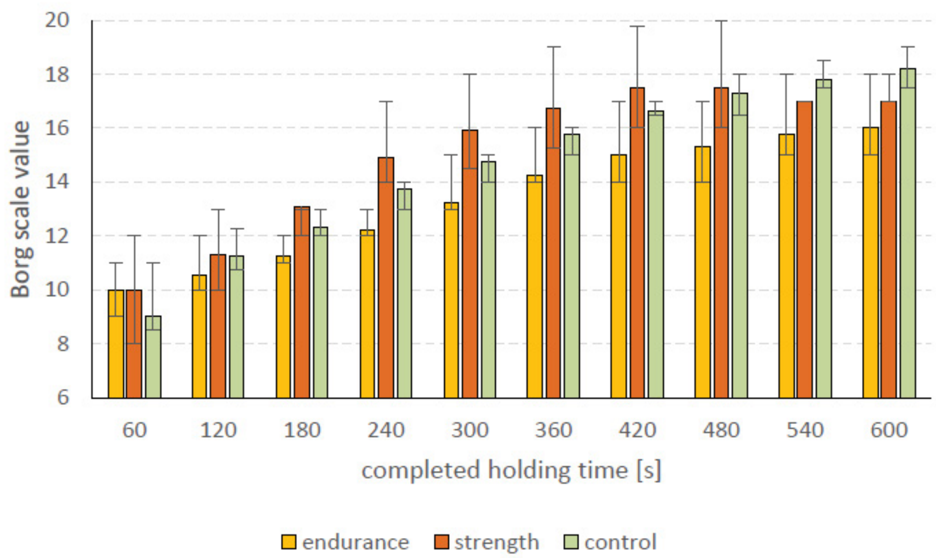


**Figure 3:** Borg scale values during the endurance task. Values are given as median values ± quartiles. No statistical differences could be detected between groups.

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## Results

Maximum holding times were shortest for ST (Figure 2), but showed significant differences only for ET vs. ST ($p<0.01$). Anyhow, Hedges gs values showed relevant differences among all groups: ET vs. ST 10.64; ET vs. C 2.38; ST vs. C 0.78. Values of perceived exertion increased over time with lowest values for the ET group, except after 60 s (Figure 3). Especially between 180 s and 420 s ST group showed highest exertion values. Although the non-parametric Kruskal-Wallis H test showed significant differences among the groups at 180, 240, 300, 420, and 600 s post hoc tests failed to verify significant group differences.

## Discussion

The study revealed a clear advantage of endurance trained but also untrained subjects over strength trained athletes with respect to their back muscle endurance capacity at 50% UBW load level. This is surprising as absolute as well as relative force levels of the ST group were superior over both other groups. In other words, they had a power reserve of 160% of their UBW, whereas endurance trained showed 128% and controls had 123%. Further, all athletes were highly competitive, thus any premature termination of the endurance task can be excluded with high certainty. Thus, the absolute as well as relative strength level of back muscles seems to be rather inversely correlated with endurance performance. The lower limit, i.e. values for persons with an even lower strength reserve, could not be determined on basis of the available data. Anyhow, it can be assumed that back muscles endurance capacity follows a U-shaped curve, i.e. we would expect to see deficits in endurance performance in persons with a very low strength reserve as well. There are indirect indications for this assumption, since values of perceived exertion were always lowest in the ET group, whereas the control group showed highest values after 480 s endurance time, unfortunately without statistical proof. However, the Borg values of the control group may be influenced by a lack of experience with respect to physical exertion in general. This is particularly evident for the value after 60 s, where the control group tended to have the lowest values with a mean value of only 9, while each of the two groups of athletes reported values of 10. Here it would make sense to carry out a repeated examination shortly after this initial examination to test whether the assessment of perceived exertion changes in the group of sedentary controls.

We did not take muscle biopsies here but it can be expected that back muscles fibre composition between the two competitive athlete groups differs significantly [6-8]. For the ST group a largely higher proportion of Type II fibres can be assumed in comparison with the ET group and also larger fibre diameters [9], resulting in early use of Type II fibres and reduced metabolic supply due to the enlarged fibre diameters.

## Conclusion

Isolated strength training like power lifting may lead to disadvantageous functional situations if endurance tasks are to be compensated by these people. Although strength trained subjects have a superior physiological reserve of their back muscle force capacity, endurance requirements at 50% UBW potentially tend to overcharge their endurance capacity, most likely due to restricted metabolic supply of their back muscles.

## Conflict of Interest Statement

Both authors have no competing interests to declare.

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