Metabolic response to strength endurance training in specifically trained and untrained males

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Introduction

There is no fixed ratio between intensity (percent of 1-RM) and the number of repetitions. Hoeger et al. (1990) indicate that the prediction of the 1-RM (load which could be lifted only once) cannot be generalized according to a number of repetitions performed. Bayer/Ramlow (1993) found e.g. a larger range between intensity and the number of repetitions in elite rowers. A higher number of repetitions is associaded with a higher loading duration and higher loading duration achieves a greater anaerobic glycolysis with lactic accumulation. The aim of this study was to predict the number of repetitions and the lactic acid concentration in three different training groups.

Methods

Thirty-nine male subjects (the subjects represented three categories: 13 untrained - no specific strength training, 13 elite athletics - specific power and explosive strength training and 13 elite wrestlers - strength endurance training) were tested to determine the maximal number of repetitions at 60 percent of 1-RM in bench press exercise (cf. fig. 1). All subjects had to perform 6 sets with a one-minute rest interval between the sets. To determine the metabolic strain, the lactic acid concentration in rest and at the end of exercise was measured. Statistical evaluation of the data was accomplished by two-way ANOVA with repeated measurements.

Tab. 1: Anthropometric dates of the different groups

age [years]	N	mean	sd	min	max
untrained	13	35.4	7.6	27	52
athletics	13	26.1	7.6	18	44
wrestler	13	25.3	10.6	16	52
body hight [cm]	**N**	**mean**	**sd**	**min**	**max**
untrained	13	179.5	5.7	172.0	192.0
athletics	13	183.5	10.0	169.0	199.0
wrestler	13	175.0	8.8	160.0	193.0
body weight [kg]	**N**	**mean**	**sd**	**min**	**max**
untrained	13	76.3	5.7	66.0	84.5
athletics	13	84.6	14.7	64.0	117.0
wrestler	13	77.9	16.1	54.0	105.0

Results (repetitions)

A significant difference in 1-RM was observed between all three groups [$F = 14.77$; $p < 0.001$; $\eta^2_p = 54.9$ %]. The 1-RM was: untrained (70.0 ± 10.1 kg), athletics (105.4 ± 22.1 kg) and wrestlers (94.0 ± 16.4 kg). The repetitions at 60 percent 1-RM decreased significantly over 6 sets [$F = 864.77$; $p < 0.001$; $\eta^2_p = 96.0$ %] (cf. tab. 2). A significant difference in repetitions at 60 % 1-RM was observed between all three groups [$F = 5.69$; $p < 0.01$; $\eta^2_p = 24.0$ %]. Post hoc single tests (Scheffé) indicate a significant difference between untrained and wrestlers [$p < 0.05$] and a significant difference between athletics and wrestlers [$p < 0.05$]. There is no difference between untrained and athletics [$p = 0.83$]. Figure 1 indicates means and sd for the three different training groups (cf. Fröhlich/Schmidtbleicher 2003).

Tab. 2: Number of repetitions at 60 % 1-RM over 6 sets of all subjects

reps	set 1	set 2	set 3	set 4	set 5	set 6
$\bar{x} \pm sd$	21.3 ± 3.4	8.2 ± 2.2	5.4 ± 1.8	4.7 ± 1.7	4.5 ± 1.4	4.3 ± 1.4

Results (lactic acid)

The ANOVA showed no difference in lactic acid concentration in rest between all three groups [$F = 1.17$; $p = 0.32$]. Lactic acid increased significantly during exercise [$F_{(5;\ 175)} = 355.21$; $p < 0.001$; $\eta^2_p = 91.0$ %] (cf. tab. 3). The increase is 90.3 % from set 1 to set 6. There is no statistic significant difference between groups [$F_{(2;\ 35)} = 2.90$; $p = 0.07$; $\eta^2_p = 14.2$%]. The p-value manqué the $p < 0.05$ line. The lactic acid concentration during exercise is about 0.6 mmol·l^{-1} higher in athletics than in the other groups (untrained and wrestlers) (cf. fig 2).

Tab. 3: Δlactic concentration at 60 % 1-RM over 6 sets of all subjects

Δlactic	set 1	set 2	set 3	set 4	set 5	set 6
$\bar{x} \pm sd$	3.1 ± 0.8	4.7 ± 0.8	5.4 ± 0.9	5.7 ± 0.8	5.8 ± 0.9	5.9 ± 0.9

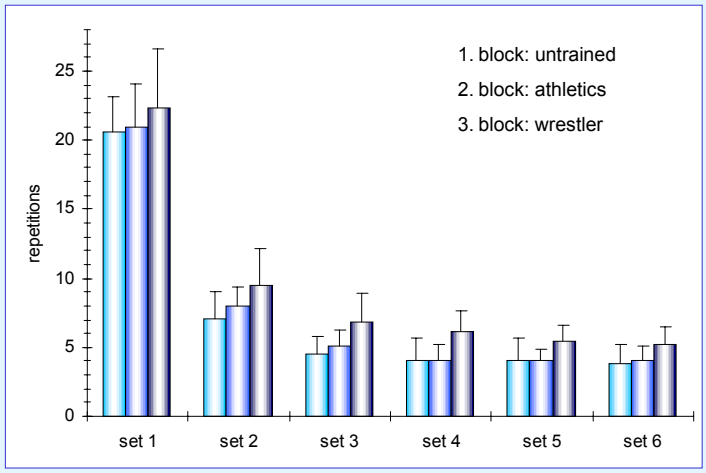

Fig. 1: Number of repetitions at 60 % 1-RM over 6 sets

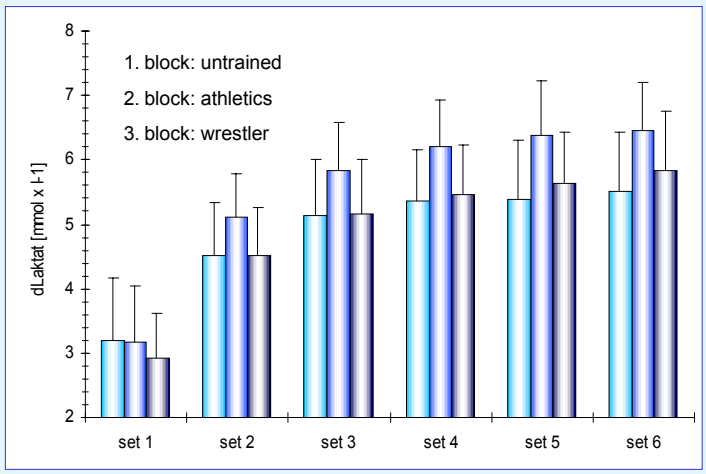

Fig. 2: Δlactic concentration at 60 % 1-RM over 6 sets

Discussion and conclusion

Training with constant load (60 % 1-RM) indicates a decrease in number of repetitions during exercise. Fröhlich/Schmidtbleicher/Emrich (2002) found the same results in hypertrophy training (85 % 1-RM) by badminton players and undergraduates. The extent of the decrease in the present study was different in the three specific groups. Wrestlers with specific strength endurance training could perform more repetitions at a given intensity than untrained and athletics. Athletics have a higher proportion of FT muscle fibres and can therefore produce more lactate at the same relative exercise intensity than subjects with a lower proportion e.g. wrestlers. This findings indicate that a specific training leads to a specific adaptation (cf. Fröhlich/Schmidtbleicher 2003).

References

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