Front Physiol. 2017 Apr 27;8:241. doi: 10.3389/fphys.2017.00241. eCollection 2017.

Clinical Applications of Iso-Inertial, Eccentric-Overload (YoYo™) Resistance Exercise.

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Author information

Abstract

In the quest for a viable non-gravity dependent method to "lift weights" in space, our laboratory introduced iso-inertial resistance (YoYo™) exercise using spinning flywheel(s), more than 25 years ago. After being thoroughly tested in individuals subjected to various established spaceflight analogs, a multi-mode YoYo™ exercise apparatus was eventually installed on the International Space Station in 2009. The method, applicable to any muscle group, provides accommodated resistance and optimal muscle loading through the full range of motion of concentric actions, and brief episodes of eccentric overload. This exercise intervention has found terrestrial applications and shown success in enhancing sports performance and preventing injury and aiding neurological or orthopedic rehabilitation. Research has proven that this technique offers unique physiological responses not possible with other exercise hardware solutions. This paper provides a brief overview of research that has made use, and explored the efficacy, of this method in healthy sedentary or physically active individuals and populations suffering from muscle wasting, disease or injury. While the collective evidence to date suggests YoYo™ offers a potent stimulus to optimize the benefits of resistance exercise, systematic research to support clinical use of this method has only begun to emerge. Thus, we also offer perspectives on unresolved issues, unexplored applications for clinical conditions, and how this particular exercise paradigm could be implemented in future clinical research and eventually being prescribed. Fields of particular interest are those aimed at promoting muscle health by preventing injury or combating muscle wasting and neurological or metabolic dysfunction due to aging or illness, or those serving in rehabilitation following trauma and/or surgery.

KEYWORDS:

clinical trials; eccentric training; flywheel exercise; rehabilitation; skeletal muscle; strength training

J Strength Cond Res. 2018 Sep 28. doi: 10.1519/JSC.0000000000002878. [Epub ahead of print]

Injury Prevention Programs Based on Flywheel vs. Body Weight Resistance in Recreational Athletes.

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Abstract

Monajati, A, Larumbe-Zabala, E, Sampson, MG, and Naclerio, F. Injury prevention programs based on flywheel vs. body weight resistance in recreational athletes. J Strength Cond Res XX(X): 000-000, 2018-This study compares the effect of an isoinertial flywheel technology vs. a traditional gravity-dependent exercise protocol on modifiable factors associated with the incidence of hamstring strain (HAM) and anterior cruciate ligament (ACL) injuries. Furthermore, the effect on repeated sprint ability was also considered. Eighteen recreationally trained volleyball players completed one of the following 6-week protocols: (a) flywheel (FY) included 3 exercises using a YoYo isoinertial-squat machine and 3 exercises with a Versa-Pulley isoinertial device, and (b) gravity-dependent (GT) involved 6 similar exercises with no external resistance (participants' body weight). Both programs consisted in 2 sessions·wk performing 2 sets of 8 repetitions with 2 minutes of rest. Outcomes included a 10-second tuck jump assessment (TJA), landing knee valgus score, hamstring and quadriceps concentric and eccentric isokinetic 60°·s peak torque, optimal peak torque localization, conventional and functional hamstring-to-quadriceps ratio, and 10-m repeated shuttle sprint ability (RSSA) test. FY improved TJA (-2, interquartile range [IQR] = -3 to -1) and valgus (-1, IQR = -1 to 0) scores, hamstring eccentric (20.37, 95% confidence interval [CI] = 9.27-31.47 N·m) and concentric (17.87, 95% CI = 0.40-35.34 N·m) peak torque, as well as the RSSA (-0.28, 95% CI = -0.45 to -0.10 seconds), whereas GT only improved hamstring eccentric peak torque (21.41, 95% CI = 9.00-33.82 N·m). A 6-week protocol using flywheel technology seems to elicit better positive adaptations to protect athletes from HAM and ACL injuries and to enhance RSSA performance compared to exercising with no external resistance other than athletes' body weight

J Sports Sci Med. 2019 Jun 1;18(2):344-350. eCollection 2019 Jun.

Effect of Flywheel Resistance Training on Balance Performance in Older Adults. A Randomized Controlled Trial.

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Abstract

This study aimed to assess the effects of flywheel resistance exercise training on postural stability and mobility in older adults and to investigate whether changes in power are related to improvements in balance. Thirty-six participants were randomly allocated to either a flywheel resistance exercise training group (ETG; n = 18) who underwent 6-weeks of training (2 to 3 days per week) or a control group (CON; n = 18). The average power and Mean Propulsive Velocity (MPV) were computed. Timed up-and-go test (TUG) and postural balance (anterior-posterior (AP) and medial-lateral (ML) center of pressure (COP) excursions) in different tasks were also assessed. Within-group analyses showed a significantly better performance in mobility (TUG, $p < 0.01$) and COP_{AP} with open eyes ($p < 0.05$) for ETG. Between-groups analyses showed significant improvements in TUG (-0.68 [-1.25 to -0.98]) and in COP_{AP} (-2.90 [-4.82 to -0.99]) in ETG compared with CON. Mean power also increased in ETG and the changes were related to those observed in stability (COP; $r = -0.378$, $p < 0.05$). In conclusion flywheel resistance exercise training improved balance and mobility in older adults as well as muscle power.

J Sci Med Sport. 2017 Oct;20(10):943-951. doi: 10.1016/j.jsams.2017.03.004. Epub 2017 Mar 21.

Skeletal muscle functional and structural adaptations after eccentric overload flywheel resistance training: a systematic review and meta-analysis.

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Abstract

OBJECTIVES:

The purpose of this meta-analysis was to examine the effect of flywheel (FW) resistance training with Eccentric Overload (FW-EOT) on muscle size and functional capacities (i.e. strength and power) in athletes and healthy subjects, and to compare FW-induced adaptations with those triggered by traditional resistance exercise interventions.

DESIGN:

A systematic review and meta-analysis of randomised controlled trials.

METHODS:

A search of electronic databases [PubMed, MEDLINE (SportDiscus), Web of Science, Scopus and PEDro] was conducted to identify all publications employing FW-EOT up to April 30, 2016. Outcomes were analyzed as continuous outcomes using a random effects model to calculate a standardized mean difference (SMD) and 95% CI. A total of 9 studies with 276 subjects and 92 effect sizes met the inclusion criteria and were included in the statistical analyses.

RESULTS:

The overall pooled estimate from the main effects analysis was 0.63 (95% CI 0.49-0.76) with a significant ($p<0.001$) Z overall effect of 9.17. No significant heterogeneity (p value=0.78) was found. The meta-analysis showed significant differences between FW-EOT vs. conventional resistance training in concentric and eccentric strength, muscle power, muscle hypertrophy, vertical jump height and running speed, favoring FW-EOT.

CONCLUSIONS:

This meta-analysis provides evidence supporting the superiority of FW-EOT, compared with traditional weight-stack exercise, to promote skeletal muscle adaptations in terms of strength, power and size in healthy subjects and athletes.

KEYWORDS:

Hypertrophy; Iso-inertial; Muscle power; Muscle strength

Sports Med Open. 2018 Dec 13;4(1):55. doi: 10.1186/s40798-018-0169-5.

Effects of Flywheel Training on Strength-Related Variables: a Meta-analysis.

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Author information

Abstract

BACKGROUND:

Strength and power development are abilities important for athletic performance in many sports. Generally, resistance training based on gravity is used to improve these qualities. Flywheel training instead utilizes kinetic energy transferred to a flywheel. This allows for eccentric overload and variable resistance throughout the movement. The aim of this review was to identify the effects of flywheeltraining on multiple strength-related variables affecting athletic performance. The meta-analysis investigates the effects on (1) muscle growth (cross-sectional area (CSA) and volume/mass), (2) maximum dynamic strength, (3) development of power, (4) development of horizontal movement, and (5) development of vertical movement.

METHODS:

The meta-analysis includes 20 experimental studies that met the inclusion criteria. The quality of included studies was ranked according to the PEDro scale. Possible bias was identified in Funnel plot analyses. To enable the compilation of all results analyses, the random effect model was carried out using the software Review Manager Version 5.3 and presented with Forest plots.

RESULTS:

Flywheel training for a period of 4-24 weeks shows statistically significant increases in all strength aspects. Effect sizes were for hypertrophy, CSA 0.59; volume/mass 0.59; maximum strength 1.33; power 1.19; horizontal 1.01 and vertical movement 0.85. The evidence is particularly strong for beneficial effects from flywheel training in the development of maximal strength and power in trained younger individuals, and utilization of this training modality in shorter more intensive blocks.

CONCLUSIONS:

Flywheel training is an effective method for improving several aspects of strength and power with importance for sports performance.

KEYWORDS:

Horizontal movement; Maximum strength; Muscle hypertrophy; Power; Vertical movement