**Title**: How much help do you need? An acute investigation into perceptions of load lifted during forced repetitions.

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Abstract

**Introduction**

An array of health benefits are attainable from low-volume, high effort, resistance training (e.g., increased metabolic rate and bone mineral density, a reduction in blood pressure, and improved muscle quality and insulin sensitivity, among others (Fisher, et al. 2017; Steele, Fisher, Skivington, et al., 2017). Further, the most common goals of resistance training; muscular strength and muscle hypertrophy - are independently strong predictors of longevity and quality of life (Ruiz, et al. 2008; Srikanthan, et al. 2014).

Recently academic debate has considered “effort” (i.e., proximity to failure) as one of the most important variables toward stimulating adaptations (Grgic, et al. 2022; Fisher, et al. 2022; Refalo, et al. 2023). In that sense, advanced overload techniques or specialized training methods are often used by the lay population and cited within the literature as methods which can maximize recruitment as a stimulus toward optimizing adaptations (Steele, Fisher, Giessing, et al., 2017). One such advanced technique is that of forced/assisted repetitions, whereby upon reaching cessation of a set of exercise (i.e., momentary failure), a trainer or training partner assists the trainee with the concentric phase of the exercise. It is theorized that this technique can augment motor unit recruitment and fatigue and enhance metabolic stress (Schoenfeld, 2011). In that sense, this technique is similar to drop-set resistance training, whereby upon reaching momentary failure the weight is reduced and the exercise continued. However, forced repetitions allow a trainee to continue to perform the eccentric phase of the exercise with a heavier weight than they are now using for the concentric exercise and thus also serves to produce an eccentric overload.

A number of studies have considered the acute response to forced repetitions including acute fatigue and perceptual responses (Fisher, Farrow, et al. 2017), as well as hormonal responses (Ahtiainen, et al. 2003; Ahtiainen, et al. 2004). However, for such a commonly utilised technique there is a dearth of empirical training studies. The only intervention study found compared different numbers of forced repetitions across groups rather than in comparison to a control group (Drinkwater, et al. 2007). A possible reason for the lack of research, and indeed a limiting factor might be the quantification of assistance provided. While some studies provide vague details e.g., *“Spotters were instructed to provide only a minimum amount of assistance necessary to allow the subject to continue the set.”* (Drinkwater, et al., 2007), and *“… upon reaching momentary failure, the research assistant provided sufficient additional force to the participant to complete the concentric phase only. … Exercise was terminated when the participant could no longer pause with the load in the isometric phase of the repetition.”* (Fisher, Farrow, et al. 2017).

Two studies did measure the amount of force provided by the spotter detailing the use of different force plates and handheld dynamometers (Ahtiainen, et al. 2003; Ahtiainen, et al. 2004). However, in the former of these studies the authors subtracted the force produced by spotters from the total volume of work (loads x sets x reps) and as such no data for the amount of assistance provided is available. In the latter of these studies (Ahtiainen, et al. 2004), the authors reported the averaged force of assistance in the last four reps as 100 ± 10 N (~10.2kg), 103 ± 10 N (~10.5kg), 128 ± 12 N (~13.1kg), and 139 ± 13 N (~14.2kg), respectively. While relative data reported that load for forced repetition sets were 12% and 30% greater than maximum repetition sets, for strength athletes and non-athletes, respectively, raw data for load lifted was not presented. As such, plot digitizer software (<https://apps.automeris.io/wpd/>) was used for figure 2 (Ahtiainen, et al. 2004), and values for the first of four sets were estimated as 129.8kg for forced reps vs. 108.3kg for maximum reps for strength athletes, and 86.8kg for forced reps and 65.3kg for maximum reps for non-athletes. However, these data represent a single study with a single exercise (smith machine squat).

Without clarity as to how much assistance is provided and thus, how much additional work is performed by a trainee, we cannot know the efficacy of advanced overload training methods such as forced repetitions. Furthermore, with a growing interest in the efficacy of supervision during resistance training (Fisher, et al. 2022), it would be interesting to better understand perceptions of assistance provided by both trainees and trainers/training partners. With the above in mind the aim of the present study was to investigate perceptions of assistance by trainers and trainees in comparison to actual assistance for the bench press exercise.

**Methods**

*Study Design*

An acute resistance training task was performed in a single session whereby participants completed a single set of smith machine bench press to momentary failure and were then assisted for two further repetitions. Trainers and trainees then estimated the percentage of the total weight that was lifted by the spotter. Actual weight lifted by spotter was recorded using a digital weight scale. The study was approved by the Ethics Committee at the first authors institution meeting the ethical standards of the Helsinki declaration and was conducted within the Sport Science Laboratories at University of Kaiserslautern-Landau.

*Participants*

A convenience sample of 48 (10 female, 38 male) trained undergraduate students were recruited for the present study (height: 178.4 ±7.5cm; mass: 73.3 ±9.8kg; age: 22.8 ±2.8years; muscle mass: 79.3± 0.1%). Exclusion criteria were based upon illness or any contraindications to physical activity identified using a physical activity readiness questionnaire, though no one was excluded. All participants read a participant information sheet, were afforded the opportunity to ask any questions, and then completed informed consent forms before any testing commenced.

*Procedures*

All participants were randomly assigned roles as both trainer and trainee on testing days and partnered with one another. Data collection occurred during scheduled classes at the end of semester and so some attrition for either role occurred based upon whether students missed one of the classes or had an injury. Thus, whilst most participants acted in both the role of spotter and trainee on either testing occasion, not all performed both roles (six participants performed only the spotter role and six participants performed only the trainee role). After a light warm-up, participants identified their typical 10-12RM for the bench press using a smith machine (these had previously been identified through regular training during the academic semester). Participant trainees completed as many repetitions as possible with good form controlling the resistance throughout each repetition. Upon reaching the point of momentary failure, a spotter assisted the trainee with only sufficient force to allow two more complete repetitions. Participant trainees provided assistance through use of a digital weight scale (Helcona) attached to the bar to measure the exact maximal force provided. The values on the dynamometer were blinded to the trainer and trainee but were recorded by the research assistant. See figure 1 for image depicting procedures for data collection. Immediately after the forced repetitions the trainer and trainee were separated and asked independently as to how much (%) assistance was provided for each of the forced repetitions. The research assistant recorded the maximal force on the digital scale for each of the forced repetitions.

*Statistical Analysis*

Complete data sets were available for 26 participants for both trainer and trainee estimations of percentage load assisted and actual loaded assisted.

Results

Discussion

Practical Applications

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