Effect of recovery period duration per muscle group on increase in strength

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Background: After intense strength training, the human body requires a recovery period to adapt and increase future strength capacity[1]. Literature suggests that for optimal recovery, most individuals need , on average, between 24 to 72 hours of rest between workouts targeting the same muscle group[1]. However, the exact duration can vary depending on other factors, such as age, fitness level, workout composition, genetics, workout intensity and participation in other sports. While general guidelines exist, personalized recommendations are limited[1].

Objective: the objective of this observational study is to determine the optimal recovery period between workouts targeting the same muscle group in a personalized training regimen, with a specific focus on maximizing the increase of strength.

Hypothesis: the hypothesises is that the exact optimal recovery period for the personalized training regime can vary a bit from the average guidelines, but will fall somewhere within the 24-72 hour range.

Methods: this study is based on a two-year dataset from a single subject, consisting of 460 recorded workouts, totalling 8677 sets and 86009 repetitions of different types of strength-building exercises. The data was collected via the workout tracking app Strong, which categories data in workouts, exercises and sets. For each workout, a measure of strength will be calculated for each performed exercise. The difference in strength indication between workouts targeting the same muscle groups will be compared to recovery periods between those workouts.

Note This study focuses exclusively on strength gains for personalized training data. The findings may not directly apply to other fitness goals, such as hypertrophy (muscle size increase) and muscular endurance, or to training regimes personalized for different individuals.

Terminology
Repetition (rep)**:** A single complete movement of an exercise.
Set**:** A group of consecutive repetitions performed without rest.
Set Volume**:** The total amount of work performed in a set (reps * sets)
Exercise: collection of sets of the same type performed during the same workout
Workout: collection of exercises performed during a single visit to the gym.

Data

The data is processed and visualized via two common data science frameworks: Pandas and Matplotlib. This data analysis is available as a Jupyter Notebook file.

Figure 1 shows the spread of the amount of rest days taken per muscle. You can see some outliers in this data, which are due to some exercises that belong to an isolated muscle group (i.e., triceps) that had occasionally been skipped for an extended duration.

To visualize the frequency of rest days taken per muscle group on average, the outliers were filtered out of the dataset. The frequency of rest days taken per muscle group was then visualized in a histogram, seen in Figure 2.

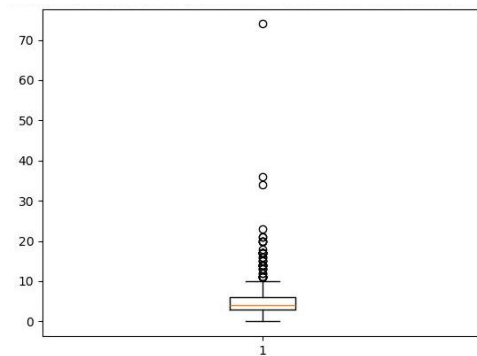For simplicity, the number of rest days were rounded up or down to a full day.

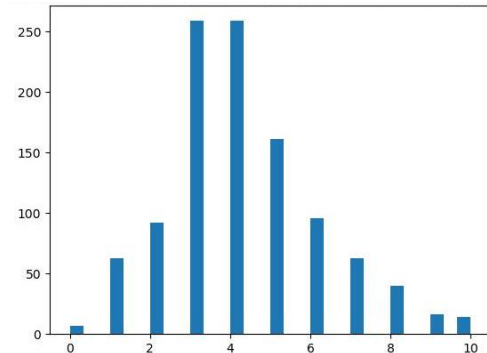*Figure 1 spread of rest days between exercises of same muscle group*

Figure 2 frequency of rest days between exercises of same muscle group

Measure of strength and progress

To measure progress in strength, it is first needed to establish how to indicate strength.

Weights used during an exercise are actually not a good indicator, without considering the number of repetitions for which this weight is moved.
When using 'Set volume' as indicator, you are multiplying the used weight by the number of repetitions that it was moved. Set volume is not a great indicator of strength either, because the relation between strength and set volume is nonlinear. As you increase the weight, the maximum amount of repetitions you can perform with that weight exponentially decreases, and vice versa when decreasing the weight.[2] (page 5)

A good indicator of strength is the Estimated 1RM (repetition max)[3]. A repetition max is the maximum amount of weight that a person could lift for an exercise for only 1 repetition. The Epley formula[3] can be used to <u>estimate</u> the 1RM for a set based on the number of repetitions and the weight. This formula would assume that the set was performed until muscle failure (lift as much repetitions as you can handle for a given weight).

When using Estimated 1RM as an indicator of strength, then progress can be measured by taking the difference in the estimated 1RM of an exercise to the previous time this exercise was executed.

Appendix

Supplementary data to this article is a Jupyter Notebook file through which the data analysis was performed. This notebook can be found in the following GitHub repository:
https://github.com/dburgt98/fitness-workout-analysis

Results

When plotting the correlation between number of rest days per muscle group (rounded to full days), we see that 3 to 4 rest days, on average, provided most optimal increase in strength, when considering Estimated 1RM as an indicator.
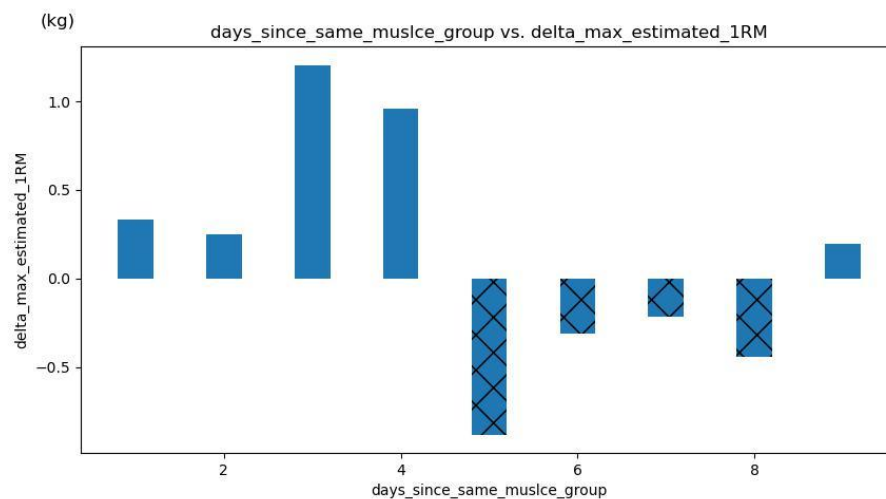
To do: add P-factor
To do: check results per muscle group individually, rather than average
To do: define progress as consistent increase over several workouts rather than only a difference to the previous workout

Conclusion

The data suggests that the optimal recovery period per muscle group between 72-96 hours for the test subject. This range does not fall in the 24-72 hour range that was expected in the hypothesis.

References

1. https://trainmore.nl/news/how-long-do-muscles-need-to-recover/

2. Brad J. Schoenfeld Loading Recommendations for Muscle Strength, Hypertrophy, and Local Endurance: A Re-Examination of the Repetition Continuum. Sports (Basel). 2021;9(2):32

3. https://en.wikipedia.org/wiki/One-repetition_maximum