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Protocol

Strength Training Guide for Personal Training Practitioners

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Abstract: Resistance exercise is the performance of physical exercises designed to improve strength, muscular, endurance, hypertrophy, and neuromuscular efficiency with the use of weights (Braith & Stewart, 2006)[1]. Resistance exercise has long been utilized for its beneficial health qualities and propensity to elicit certain desired physiological changes (Fry, 2004)[2]. There has been a recent, and significant, increase in resistance exercise activity in American adults (NCHS, 2018)[3] attributable to factors such as autonomous compulsion and self fulfilment to extrinsic factors like health and physical appearance (Fisher et al., 2017; Heinrich et al., 2014; Ingledew & Markland, 2008)[4,5,6]. As such, there is an ever-increasing need for educational material regarding resistance exercise, its benefits, purpose, and manner in which it should be conducted. Purpose- to (a) provide resistance exercise-based educational material regarding the background and rationale behind resistance training; (b) to provide a specific resistance-based exercise program to elicit strength gain; (c) to provide individuals with the knowledge to safely and effectively engage in said program; and (d) to provide the participant with expected physiological adaptations to completing the program. Methods- Two 6-week, 5-day per week resistance exercise programs – with a brief nutritional guide accompaniment – are outlined for a hypothetical participant, age 25-40, of moderate experience with fitness training, and with the goal of strength gain and moderate fat loss as a secondary goal. Results- Anticipated benefits of the program include: increased maximal strength caused by training above 85% 1RM for 2-6 sets of 1-6 reps; increased synergistic muscle groups strength which will contribute to improved prime mover strength; hypertrophy of skeletal muscles throughout the body, induced by lifts of 67-85% 1 rep max (RM) for 3-6 sets of 6-12 reps and increased resting energy expenditure (basal metabolic rate) accompanied by improved body composition. Conclusion- Continued progression though this protocol with modifications to resistance include potential improved running speed, explosive power potential, and other anaerobic sport performance factors, as well as enhanced neuromuscular efficiency associated with increased prime mover force production capabilities.

Keywords: Hypertrophy, Maximal strength, Prime movers, Resistance training, Synergists

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1. Introduction

The recent increase in the practice of strength training and resistance training may have a varied causation (Box et al., 2019)[7], ranging from intrinsic factors, such as autonomous compulsion and self fulfilment, to extrinsic factors like health and physical appearance (Fisher et al., 2017; Heinrich et al., 2014; Ingledew & Markland, 2008)[4,5,6]. According to the National Center for Health Statistics (NCHS), a principal agency of the United States Federal Statistical System, 23.2% of the 2018 United States population (representing more than 79 million individuals over the age of 18) engages in both aerobic and muscle-strengthening activities (NCHS, 2018)[3]. This is an increase of almost 3% since 2006 (NCHS, 2018)[3]. There is also evidence of recent increased attention to strength training and general health-related fitness being taught in compulsory K-12 physical education (Pennington, Shiver, McEntyre, & Brock, 2022; Richards, Pennington, &

Sinelnikov, 2019; Pennington, 2020a; Pennington, 2020b)[8,9,10,11]. As values placed on health and fitness are established in early educational experiences tend to be perpetuated into adulthood (Pennington & Nelson, 2020)[12], statistically speaking, strength training in healthy adults has been on an astronomical rise, and it appears this trend will continue well into the future, as education on the benefits of resistance exercise becomes more widely consumed.

As can be observed from the above population trends, there is an ever-growing populace of individuals who require guidance and scientifically supported information on resistance exercise (Pennington, 2014; Pennington, 2015; Pennington, 2016)[13,14,15]. Therefore, the purpose of this article is multifaceted; the purposes are to (a) provide resistance exercise-based education material regarding the background and rationale behind resistance training; (b) to provide a specific resistance-based exercise program to elicit strength gain; (c) to provide individuals with the knowledge to safely and effectively engage in said program; and (d) to provide the participant with expected physiological adaptations to completing the program. Two 6-week, 5-day per week resistance exercise programs – with a brief nutritional guide accompaniment – are outlined for a hypothetical participant, age 25-40, of moderate experience with fitness training, and with the goal of strength gain and moderate fat loss as a secondary goal.

1.1. Background and Rationale Behind Resistance Training

Resistance exercise is the performance of physical exercises designed to improve strength, muscular, endurance, hypertrophy, and neuromuscular efficiency with the use of weights (Braith & Stewart, 2006)[1]. Resistance exercise has long been utilized for its beneficial health qualities and propensity to elicit certain desired physiological changes (Fry, 2004)[2]. In fact, "physical activity has been proven to reduce the risk of chronic diseases and disorders that are related to lifestyle, such as increased triglycerides and cholesterol levels, obesity, glucose tolerance, high blood pressure, coronary heart disease, and strokes," (NASM, 2007, p. 4.)[16]. Resistance exercise has been shown to significantly increase the loss of adipose tissue via increased resting metabolic rate (Alexander, 2002)[17] and increase lean body mass (Peterson, Sen, Gordon, 2011)[18]. This results in a leaner, healthier physique for those who engage in resistance exercise.

In regards to practical applications, increased maximal strength can improve running speed, explosive power potential, and other anaerobic sport performance factors (Cronin et al., 2000; Ross et al., 2009; Shiau et al., 2018)[19,20,21] in athletes and non-athletes alike. The beneficial effect of maximal strength training can be seen in as little as eight weeks, and has seen successful utilization by even long-distance runners and competitive swimmers (Storen et al., 2008; Strass, 1988)[22,23]. Strength-based resistance training, thus, has extensive sport performance-improving potential and lifestyle aid, as well – including areas such as stress reduction, sleep improvement (Pennington, 2018)[24], injury prevention (Pennington, 2020c)[25], and improved quality of life for individuals with disabilities (Brorman, & Pennington, 2021; Law & Pennington, 2021; Kelly & Pennington, 2021; Nelson et al., 2020; Moore & Pennington, 2021)[26,27,28,29,30]. It is for this reason that the accessible education on resistance training holds a crucial importance and, therefore, must be made available.

1.2. Resistance-based Exercise Program to Elicit Strength Gain

1.2.1. Protocol

For core movements such as bench press (and its variations), squat, and certain arm and shoulder exercises, the following protocol adheres to the guidelines established by the National Strength and Conditioning Association (NSCA) for maximal strength training. Following years of practice and scientific examination, the NSCA determined that the most effective manner for increasing maximum strength is lifting ≥85% of an

individual's 1 repetition maximum (1RM) for 1-6 repetitions, 2-6 sets, and utilizing a rest period of 2-5 minutes (Haff & Triplett, 2015)[31].

Stabilization lifts stress both prime movers and their stabilization musculature – for example, the rotator cuff (stabilizer) and the pectoralis major (prime mover) are both taxed during a dumbbell chest press. Core exercises include the bench press, squat, and deadlift. Auxiliary lifts include most other movements, and are often sport or end-goal specific (Shepard & Goss, 1977)[32]. It should be noted that, while core movements are utilized within this program (at least one for every day), they are specifically named. "Core" exercises stated in the following program include exercise that tax the abdominals and obliques, such as crunches or Russian twists. Regarding stabilization and auxiliary lifts, this protocol follows the guidelines established by the NSCA for hypertrophy (i.e., the increase in size of muscle cells). According to the NSCA, the most effective manner of resistance exercise for inducing hypertrophy is performing 67-85% 1RM for 6-12 reps, 3-6 sets, with a rest time of 30-90 seconds between sets (Haff & Triplett, 2015)[31]. Hypertrophy programming was used for stabilization and auxiliary lifts within this protocol in the stead of strength programming. The purpose therein being injury prevention, as overloading non-core exercises can increase risk of injury (Kolber et al., 2010)[33].

The following program is separated into two six-week, 5-days per week protocols. It should be noted that, in order to properly adhere to said program, an individual's 1RM (the absolute most weight that can be successfully lifted for one full repetition for a specific exercise) be known for various lifts. The exercise program below, organized into ten tables (Table 1 to Table 10, a separate table for each day of the 12-week protocol) repeats each week. For example, if the program is started on a Monday, every Monday after will be "Day 1," and so on. After six weeks have passed, the second protocol can be followed in the same fashion. Each table is organized into muscle group and day number with exercises, volume, and rest noted appropriately. Thus, in order to adhere to the program, one must simply follow the exercises in order, performing each for the required number of sets and reps (volume) and allowing their body to recovery for the specified length of time (rest).

Supersets, compound sets, and drop sets are utilized throughout this program. A superset "involves two sequentially (without rest between) performed exercises that stress two opposing muscles or muscle areas" (Haff & Triplett, 2015, p. 450)[31]. For example, barbell biceps curls and overhead triceps extensions. Compound sets work almost identically, though the same muscle groups are stressed in these separate lifts. For example, barbell biceps curls and neutral-grip dumbbell biceps curls. Drop sets refer to the performance of an exercise (often until failure) followed immediately by a reduction of weight and continuation of the same exercise. For example, beginning a drop set of barbell biceps curls with a 60-pound barbell, and reducing the weight 5-10 pounds at the conclusion of each set without rest between sets. These lifts were included due to their tendency to increase hypertrophic characteristics of exercises by increasing time under tension (Schoenfeld, 2011)[34].

Nutrition and safety considerations follow the program. The nutrition information below offers education that, when combined with the resistance training program, may work to maximize the beneficial effects of said program. The safety considerations offer information that may reduce risk for injury while following the program and therefore require adherence.

1.2.2. Practice Repetitions

Squat and bench "practice" is implemented based upon the principle of repeated movement patterns and their relationship with increased neuromuscular efficiency, often termed "motor learning" (Wolpert et al., 2001)[35]. Much like a child practicing writing, thus resulting in increased fine motor control, or a baseball player training in a batting

cage, "practicing" the squat and bench press [i.e., developing proper lifting form and perfecting the movement with limited/no resistance] may increase neural drive and efficiency of prime mover musculature, resulting in an increased bench and squat 1RM (Yue & Cole, 1992)[36]. During practice lifts, full body tension (activating all major muscle groups and stabilizing the joints throughout the kinetic chain; (Park, 2021)[37]) should be induced while lifting ≤50% 1RM for 1-2 sets. Full body tension is suggested due to its propensity to increase neural drive throughout the kinetic chain, allowing for greater maximal force production capabilities (Kibler et al., 2006)[38]. This is in-line with research that explored the connection between multiple muscle groups working together to increase maximal force (Archontides & Fazey, 1993)[39].

1.2.3. Safety Considerations

Lifting ≥85% 1RM for auxiliary movements (exercises that stress specific muscle groups often accompanied by a sport or end-goal specific purpose; (Shepard & Goss, 1977)[32]) - such as chest flies - increase the risk for injury (even in advanced lifters) (Kolber et al., 2010)[33]. As synergistic muscle groups (muscle groups that assist indirectly in a movement performed by prime movers or agonists, which are the muscles most directly involved in bringing about a certain movement; (Haff & Triplett, 2008)[40]) contribute to overall net force during core exercises, strengthening said muscle groups will increase maximum strength (Shinohara et al., 2009)[41]. Thus, the strengthening of synergistic muscle groups is necessary for maximal strength improvements, yet pose an increased risk for injury. Therefore, hypertrophy programming (which utilizes sub-maximal weight ranges from 67-85% 1RM; (Haff & Triplett, 2008)[40]) was utilized for the training of synergistic muscle groups within this program.

As is the case for any individual attempting new physical activity demands, one should speak with one's physician before exercise; use a spotter and barbell clamps; hydrate before activity and throughout; and wear close-toed shoes.

2. Exercise Program

Table 1. Chest. Weeks 1-6

Day 1: Chest	Volume	Rest
Barbell Bench Press	2x6 @ 85%	2-5 Minutes
Dumbbell Single Arm Chest Press (neutral bench)	1x12 @ 67%, 1x10 @ 70%, 1x8 @ 77%, 1x6 @ 83%	30-90s
Incline Dumbbell press	2x6 @ 85%	2-5 Minutes
Dumbbell Decline Chest flies	4x8-12, Increasing weight	30-90s
(Superset with) Dumbbell Incline Chest Flies	4x8-12, Increasing weight	30-90s
Squat practice, core, stretch	-	-

Table 2. Arms. Weeks 1-6

Day 2: Arms	Volume	Rest
EZ Bar Preacher Curls	12, 10, 8, 6 -increasing weight to 85% 1RM	60-90s
Seated Incline Dumbbell Curls	4x10 - Increasing Weight	
Straight Bar Cable Curls	10, 8, Failure - Increasing Weight Each Set	
(Superset with) Rope Triceps Cable Push Downs	10, 8, Failure - Increasing Weight Each Set	
Single-arm Overhead Dumbbell Triceps Extensions	4x10 - Increasing Weight	
EZ Bar Skull Crushers	12, 10, 8 Increasing Weight - 6 @ 85% 1RM	

Table 3. Legs. Weeks 1-6

Day 3: Legs	Volume	Rest
Seated Leg Extensions	3x10 - Increasing Weight	60-90s
Barbell Romanian Deadlifts	3x10 - Increasing Weight	
Barbell Back Squat	2x5 @ 85%	2-5 Minutes
Weighted Calf Raises	4x10 Increasing Weight	60-90s
Dumbbell Box Step-Ups	3x8 Each Leg -Moderate Weight	90s
(Compound set with) Body Weight Box Jumps	3x8	

Table 4. Shoulders. Weeks 1-6

Day 4: Shoulders	Volume	Rest
Barbell Military Strict Press	2x4 @ 85%, AMRAP @ 85%	2-5 Minutes
Dumbbell Lateral Raises	3x10 - Increasing Weight	60-90s
(Compound set with) Dumbbell Front Raises		
Dumbbell Arnold Press	2x5 @ 85%	2-5 Minutes
Single Arm Dumbbell Farmers Walks	3x30s Each Arm	60-90s
Bench Practice, Core, Stretch	-	-

Table 5. Back. Weeks 1-6

Day 5: Back	Volume	Rest
Body Weight Pullups	3x8	60-90s
Single Arm Dumbbell Lawn Mower Rows	2x6 @ 85%	2-5 Minutes
Seated Close Grip Cable Pulldowns	3x4 @ 87%	2-5 Minutes
Bent Over Barbell Rows	4x10 Increasing Weight	60-90s
Straight Arm Cable Lat Pulldown		
Bodyweight Back Extensions	3x10, 1xFailure	

Table 6. Chest. Weeks 7-12

Day 1: Chest	Volume	Rest
Barbell Incline Bench Press	2x6 @ 85%	2-5 Minutes
Dumbbell Single Arm Chest Press (incline bench)	1x12 @ 67%, 1x10 @ 70%, 1x8 @ 77%, 1x6 @ 83%	30-90s
Dumbbell Bench Press	2x6 @ 85%	2-5 Minutes
Dumbbell Incline Chest Flies	4x8-12, Increasing weight	30-90s
(Compound set with) Dumbbell Incline Chest Flies	4x8-12, Increasing weight	
Squat practice, core, stretch	-	-

Table 7. Arms. Weeks 7-12

Day 2: Arms	Volume	Rest
EZ Bar reverse grip curls (standing)	12, 10, 8, 6 – increasing weight to 85% 1RM	60-90s
Dumbbell Preacher Curls	4x10 Increasing Weight	
Close-grip Cable Curls	10, 8, Failure - Increasing Weight Each Set	
(Superset with) Standing Cable Crossover Triceps Extension	10, 8, 6 -Increasing Weight, Drop set to Failure	
Seated Dumbbell Overhead Triceps Extension	4x10 Increasing Weight	
Weighted Triceps Dips	12, 10, 8 (Increasing Weight), To-Failure	

Table 8. Legs. Weeks 7-12

Day 3: Legs	Volume	Rest
Seated Machine Leg Curls	3x10 Increasing Weight	60-90s
Leg Press		
Barbell Deadlift	2x5 @ 85%	2-5 Minutes
Machine Calf Raises	4x10 Increasing Weight	60-90s
Iso-Lunges	3x8	
Bench Practice & Stretch	-	-

Table 9. Shoulders. Weeks 7-12

Day 4: Shoulders	Volume	Rest
Dumbbell Military Press	2x4 @ 85%, AMRAP @ 85%	2-5 Minutes
Cable Crossover Lateral Raises	4x10 – Increasing Weight	60-90s
(Compound set with) Alternating Dumbbell Front Raises		
Seated Dumbbell Rear Delt Fly	3x10 – Increasing Weight	
Trap Bar Shoulder Shrugs	12,10,8, To-failure – Increasing Weight	

Table 10. Back. Weeks 7-12

Day 5: Back	Volume	Rest
Single Arm Seated Cable Lat Pulldowns	3x10 – Increasing Weight	60-90s
Seated Wide Grip Cable Row	3x6 @ 85%	2-5 Minutes
Seated Wide Grip Lat Pulldowns	4x4 @ 90 %	
Single Arm Dumbbell Lawn Mower Rows	4x10 – Increasing Weight	60-90s
Back Extension Machine		

3. Nutrition Suggestions

While athletes may periodically attempt to promote skeletal muscle hypertrophy, key nutritional issues are broader than those pertinent to hypertrophy, and include an appreciation of the sports supplement industry; the strategic timing of nutrient intake to maximize fueling and recovery objectives; plus achievement of pre-competition body mass requirements. Total energy and macronutrient intakes of strength-power athletes are generally high, but intakes tend to be unremarkable when expressed relative to body mass (Slater & Phillips, 2011)[42].

In their book, *The Essentials of Strength Training and Conditioning,* (Gregory Haff and Travis Triplett, 2015)[31] suggest weight-training athletes with the goal of strength-gain consume between 5-6 grams of carbohydrates/kg bodyweight per day and at minimum 1.4-1.7 grams of protein/kg bodyweight per day. To prevent further muscle breakdown post exercise, 30-100 grams of high-glycemic carbohydrates should be ingested within 30

minutes post-exercise along with 25-50g "fast, high-quality, leucine-rich (2-3g leucine)" protein. By "fast, high quality" protein, the aforementioned authors speak of concentrated/isolated forms of protein. These are often found in the form of isolated whey protein powder, which is both nutritionally dense and easily absorbed within the body (Luhovyy et al., 2007)[43]. A good rule of thumb for those looking to elicit hypertrophy or strength gain is to consume carbohydrates: protein in a 2:1 ratio immediately following heavy resistance exercise - especially if a period of fasting was taken before the exercise (at least three hours without a carbohydrates/protein rich meal) (Haff & Triplett, 2008)[40].

4. Conclusion

The above program is a combination of hypertrophy and maximal strength protocols designed to be performed over a twelve-week period with the inclusion of nutritional suggestions. The purpose of the article was to provide a hypothetical participant, age 25-40, of moderate experience with fitness training, and with the goal of strength gain and moderate fat loss as a secondary goal, a program to meet said objectives. As such, if one were to faithfully commit to the above program and accompanying nutritional suggestions, the following physiological adaptations could be expected:

- Increased maximal strength caused by training above 85% 1RM for 2-6 sets of 1-6 reps (Haff & Triplett, 2008)[40].
- Increased synergistic muscle groups strength, which will contribute to improved prime mover strength (Shinohara et al., 2009)[41].
- Hypertrophy of muscles throughout the body, induced by lifts of 67-85% 1RM for 3-6 sets of 6-12 reps and nutritionally supported by 5-6 grams of carbohydrates/kg bodyweight per day and at minimum 1.4-1.7 grams of protein/kg bodyweight per day (Haff & Triplett, 2008)[40].
- Increased resting energy expenditure (i.e., basal metabolic rate) accompanied by improved body composition (Hunter et al., 2004)[44].
- Potentially improved running speed, explosive power potential, and other anaerobic sport performance factors (Cronin et al., 2000; Ross et al., 2009; Shiau et al., 2018)[19,20,21].
- Enhanced neuromuscular efficiency associated with increased prime mover force production capabilities (Yue & Cole, 1992)[36].

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Conflict of Interest

There are no conflicts of interest.

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