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UWTSD Sport and Exercise Science Physiological Testing Protocols

Determination of 1RM Bench Press and Leg Press Strength

Taken From:

Lab 24

**Housh, T.J., Cramer, J.T., Weir, J.P., Beck, T.W. and
Johnson, G.O. (2016). Laboratory manual for
Exercise Physiology, Exercise Testing and Physical
Activity. London: Routledge.**

BACKGROUND

The one-repetition maximum, or 1-RM, refers to the maximum amount of weight that can be lifted one time. The 1-RM is a standard index to quantify muscle strength. A 1-RM determination can be made for any dynamic constant external resistance (DCER; formerly known as isotonic) strength exercise, such as the bench press, leg extension and flexion, leg press, squat, or power clean. In addition, 1-RM testing can be performed using free weights or machine exercises. The procedure is a trial-and-error method where, after a warm-up period, progressively heavier weights are lifted one time until the subject cannot successfully complete the lift of a given weight.¹ The weight is then reduced until the heaviest successful weight is determined.



PHOTO 24.1 Bench press with spotter. The subject should lower the weight slowly until the barbell touches the mid-chest.



PHOTO 24.2 Bench press with spotter. During ascent and descent the forearms should be vertical to the floor and parallel to each other.

In performing 1-RM testing for a given exercise it is helpful (but not required) to have subjects with some minimal level of weightlifting experience, because strength exercises are a motor skill that improves with practice. Therefore, a 1-RM value is affected not only by the subject's strength, but also by the subject's skill in performing the task. In addition, prior experience allows subjects to estimate their strength more accurately prior to testing. This estimate helps eliminate unnecessary lifts that are either too easy or too hard, so that the testing is efficient and the effects of fatigue are minimised.

In this laboratory you will learn to perform 1-RM strength testing for bench press and leg press exercises. You will also compare the 1-RM strength values to age- and gender-specific norms. Percentile rank norms for strength relative to body weight (1-RM strength in lbs/body weight in lbs) are provided in tables 24.1 through 24.4 for the bench press and leg press exercises for males and females.

Bench Press

The bench press is a common exercise in both training and testing (see photos 24.1 and 24.2). The motion of the bench press is analogous to a pushup, except the subject lies on his or her back and the resistance is supplied by a barbell or a bench press machine. The pectoral muscles, triceps brachii, and anterior deltoid muscles are the primary muscles involved in the lift. Because the use of a barbell requires that the subject balance the resistance in addition to lifting the weight, the 1-RM from a free weight bench press may be quite different from the 1-RM determined on a machine. Further, because the mechanics of the different machines vary, the 1-RM from the same subject on different machines may also differ substantially. These factors should be kept in mind when interpreting the results relative to the normative values provided in tables 24.1 and 24.2.

Percentile rank norms for bench press 1-RM relative to body weight by age for males.³ TABLE 24.1

Percentile rank	20–29	30–39	40–49	50–59	60–69
90	1.48	1.24	1.10	0.97	0.89
80	1.32	1.12	1.00	0.90	0.82
70	1.22	1.04	0.93	0.84	0.77
60	1.14	0.98	0.88	0.79	0.72
50	1.06	0.93	0.84	0.75	0.68
40	0.99	0.88	0.80	0.71	0.66
30	0.93	0.83	0.76	0.68	0.63
20	0.88	0.78	0.72	0.63	0.57
10	0.80	0.71	0.65	0.57	0.53

Note: Values are bench press 1-RM in lbs/body weight in lbs.

Percentile rank norms for bench press 1-RM relative to body weight by age for females.³ TABLE 24.2

Percentile rank	20–29	30–39	40–49	50–59	60–69
90	0.54	0.49	0.46	0.40	0.41
80	0.49	0.45	0.40	0.37	0.38
70	0.42	0.42	0.38	0.35	0.36
60	0.41	0.41	0.37	0.33	0.32
50	0.40	0.38	0.34	0.31	0.30
40	0.37	0.37	0.32	0.28	0.29
30	0.35	0.34	0.30	0.26	0.28
20	0.33	0.32	0.27	0.23	0.26
10	0.30	0.27	0.23	0.19	0.25

Note: Values are bench press 1-RM in lbs/body weight in lbs.

When using free weights, a failed attempt to lift a weight may result in injury if the bar becomes out of control. Therefore, an experienced “spotter” should be ready to help the subject lift the weight when the attempt is clearly going to fail.² Most bench press machines do not require the use of a spotter.

For the free weight bench press, the subject should lie supine on the bench with both feet flat on the floor with the buttocks and shoulders in contact with the bench. The subject should grip the barbell with a closed grip. That is, the thumb should wrap around the barbell so that it cannot roll out of the hand. Grip width should be slightly wider than the shoulders and evenly spaced so that the load is the same on each arm. The barbell should then be removed from the bench press racks. The spotter may help the

subject by assisting the “liftoff.” After the liftoff, the subject should lower the weight slowly until the barbell touches the mid-chest.² This should take 1 to 2 seconds. As soon as the barbell touches the chest, the subject should lift it upward until the elbows are locked. During the descent and ascent, the forearms should be parallel to each other and oriented vertical to the floor.² After the lift, the spotter may help the subject place the barbell on the racks. Lifts are not acceptable if the barbell bounces off the chest or if the buttocks come off the bench.

Leg Press (see photos 24.3 and 24.4)

The leg press is a machine-based exercise that primarily involves the simultaneous activation of the leg extensors (quadriceps) and thigh extensors (gluteal muscles and hamstrings). There are several different types of machines, and the body position can vary considerably from machine to machine, which will affect the amount of weight that can be lifted. Therefore, as with the bench press, caution should be used when interpreting the normative leg press values in tables 24.3 and 24.4. Most machines allow you to alter the angle between the torso and thigh, and, if possible, this should be set to about 90 degrees.²

TABLE 24.3 Percentile rank norms for leg press 1-RM relative to body weight by age for males.³

Percentile rank	20–29	30–39	40–49	50–59	60–69
90	2.27	2.07	1.92	1.80	1.73
80	2.13	1.93	1.82	1.71	1.62
70	2.05	1.85	1.74	1.64	1.56
60	1.97	1.77	1.68	1.58	1.49
50	1.91	1.71	1.62	1.52	1.43
40	1.83	1.65	1.57	1.46	1.38
30	1.74	1.59	1.51	1.39	1.30
20	1.63	1.52	1.44	1.32	1.25
10	1.51	1.43	1.35	1.22	1.16

Note: Values are bench press 1-RM in lbs/body weight in lbs.

Percentile rank norms for leg press 1-RM relative to body weight by age for females.³

TABLE 24.4

Percentile rank	20–29	30–39	40–49	50–59	60–69
90	2.05	1.73	1.63	1.51	1.40
80	1.66	1.50	1.46	1.30	1.25
70	1.42	1.47	1.35	1.24	1.18
60	1.36	1.32	1.26	1.18	1.15
50	1.32	1.26	1.19	1.09	1.08
40	1.25	1.21	1.12	1.03	1.04
30	1.23	1.16	1.03	0.95	0.98
20	1.13	1.09	0.94	0.86	0.94
10	1.02	0.94	0.76	0.75	0.84

Note: Values are bench press 1-RM in lbs/body weight in lbs.

At the start of the lift, the feet should be about shoulder-width apart and the toes pointed up or in a slightly “toe out” position. The shoulders and buttocks should be firmly braced against the machine.² Most leg press machines have hand grips that the subject can use to help stabilise the torso during the lift. Once positioned, the subject will unrack the weight so that the legs are fully extended (although the legs should not be hyperextended at the start of the lift). From full extension, the subject lowers the

weight slowly until the angle at the knee joint reaches approximately 90 degrees (photo 24.3), and then extends the legs and thighs until the legs are again fully extended (photo 24.4). The subject should keep the legs in line with the hips and ankles, so that the legs do not track in (knock-kneed) or out.²



PHOTO 24.3 Leg press. The subject lowers the weight slowly until the angle at the knee reaches approximately 90 degrees.



PHOTO 24.4 Leg press. The subject should keep the legs in line with the hips and ankles.

KNOW THESE TERMS & ABBREVIATIONS

- DCER = dynamic constant external resistance
- 1-RM = one-repetition maximum, a standard index to quantify muscle strength that refers to the maximum amount of weight that can be lifted one time
- leg extensors = the quadriceps, made up of the rectus femoris, vastus lateralis, vastus intermedius, and vastus medialis
- thigh extensors = the gluteal muscles (gluteus maximus and gluteus medius) and the hamstrings (biceps femoris, semitendinosus, and semimembranosus)
- hyperextension = extension of a joint beyond the normal range of motion

PROCEDURES (see photos 24.1 to 24.4)

1. Have the subject estimate his or her 1-RM strength and record it on worksheet 24.1.
2. Have the subject perform a general warm-up (3 to 5 minutes) of the body area to be tested.
3. Continue the warm-up by performing eight repetitions at a weight equal to 50% of the estimated 1-RM and three repetitions at 70% of the estimated 1-RM.
4. To determine the 1-RM, perform a single repetition at a heavier weight than that used during the warm-up. The increase in weight should be based on the relative ease or difficulty of the set in the warm-up.
5. Repeat performing single repetitions using progressively heavier weights until a weight is reached that cannot be successfully lifted. Adjust the increases in weight so that increments are approximately evenly spaced and so that at least two single lifts are performed between the weight used in the warm-up and the estimated 1-RM.
6. At failure, decrease the weight to a level approximately midway between the last successful lift and the weight at failure.
7. Repeat using heavier or lighter weights until the desired level of precision is achieved (usually within about 2.5kg) and record the 1-RM weight on worksheet 24.1.
8. Rest intervals between single lifts should be between 1 and 5 minutes.^{4,5}
9. Try to determine the 1-RM in about three to five single lifts, excluding warm-up lifts.¹
10. To increase time efficiency, more than one subject can be tested at a given station, so that one person is performing lifts while the others are resting.

Worksheet 24.1 DETERMINATION OF ONE-REPETITION MAXIMUM STRENGTH

Name _____ Date _____

Gender: _____

Body Weight: _____ lbs

Age: _____

Mode of lift: _____

Estimated 1-RM lbs: _____

WARM-UP

1. _____ repetitions at _____ lbs (approximately 50% of estimated 1-RM)

2. _____ repetitions at _____ lbs (approximately 70% of estimated 1-RM)

1-RM TESTING

1. Circle: success failure at _____ lbs

2. Circle: success failure at _____ lbs

3. Circle: success failure at _____ lbs

4. Circle: success failure at _____ lbs

5. Circle: success failure at _____ lbs

6. Circle: success failure at _____ lbs

7. Circle: success failure at _____ lbs

1-RM/body weight _____

Percentile rank classification for 1-RM in lbs/body weight in lbs = _____ (see tables 24.1–24.4)

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