

Muscle Performance and Physical Function Core

Available Tests

Assessment of Muscle Performance

Muscle performance of the upper body and lower extremities is quantified using Keiser A420 equipment and integrated software. The Keiser A420 is the latest in a series of exercise machines developed for the purpose of research. It is designed to produce accurate position, velocity, power, and acceleration information throughout the exercise range of motion.

Primary measurements available are:

1. **Strength** — The one-repetition maximum (1RM) is defined as the maximal amount of weight an individual can lift one time, and one time only, through their full range of motion using proper form. It is the optimal method for quantifying dynamic strength and the Keiser A420 system has been designed to specifically administer this measure. Our standardized 1RM testing protocol provides adequate warm-up, optimizes performance, prevents injury and minimizes fatigue.
2. **Power** — Muscle power is the product of the force and velocity of movement. It has emerged as an equally, if not more important measure of muscle performance than strength and a strong predictor of physical function and mobility. We have been at the forefront of this science and the Keiser A420 system is the leading technology for capturing this outcome. Power can be assessed at multiple predetermined percentages of the 1RM (e.g., 40, 50, 60, 70 and 80%). Peak power and power generated at the various percentages of the 1RM will be used for analyses.
3. **Fatigue** — An individual's susceptibility or resistance to fatigue has great relevance to the ability to perform and remain independent in activities of daily living. The Keiser A420 system allows the quantitative assessment of fatigue while performing repeated contractions at a resistance relative to a moderate percentage (e.g., 70 or 80%) of the 1RM.

Assessment of Physical Function and Mobility

Measures of physical function and mobility have emerged as important metrics of health span because of their predictive ability for hospitalization, disability, quality of life and even mortality. Several measures are described below.

1. **Short Physical Performance Battery (SPPB)** - The SPPB captures domains of strength, endurance, and balance and is highly predictive of subsequent disability. Briefly, the SPPB score is based on timed measures of standing balance, walking speed, and rising from a chair. Each of the three performance measures is assigned a score ranging from 0 to 4, with 4 indicating the highest level of performance and 0 the inability to complete the test. A summary score (range 0-12) is subsequently calculated by adding the three scores. Infrared photocells and load responsive switch mats are employed to execute these measures with high precision.
2. **Timed Up and Go (TUG)** - The TUG is a basic test of mobility and balance (rising from a chair, walking a short distance, turning around, returning to the chair) that has demonstrated strong predictive ability for falls. It has excellent test-retest reliability and good inter-rater reliability. The TUG can be easily modified to incorporate a cognitive component (counting backwards from a specified number) or a manual component (carrying a cup of water).
3. **Unloaded and Loaded Gait Speed** - Walking distance in a defined time period (e.g., the 6-minute walk) and the time to walk a predetermined distance (e.g., 4m, 10m, or 50m) are the most studied outcomes of lower body function in epidemiological and intervention studies and have great utility in many subject populations. The MPPFc can administer measures of gait speed

and time over specified distances in a dedicated hallway of $\geq 50\text{m}$ using a wireless timing apparatus that records performance to the nearest 0.001 sec. The low ceiling of many of these measures, however, is widely recognized. We and others have supported the use of more challenging metrics of physical performance in higher-functioning community dwelling individuals, such as the timed 400m walk or the 50m walk while carrying a modest load equivalent to 10-20% body weight.

4. **Unloaded and Loaded Stair Climb Time** - Stair climb time will be assessed using a standard riser (rise of approximately 17 cm and tread width of ~ 30 cm) of stairs. In brief, the subject will be asked to ascend a 12 rise set of stairs as fast as they can. Subjects can ascend holding the railing or using their assistive device if necessary. A precise wireless timing system will quantify performance to 0.001sec. As a more challenging metric of physical function subjects will also perform the stair climb measure while carrying a modest load (10-20% of baseline body weight) in two equally weighted canvas bags.
5. **Sit-to-Stand Transitions** - Difficulty in rising from a chair is an often reported symptom of functional limitation and is strongly associated with muscle strength. We will test this ability by measuring the time to perform either 5 or 10 repeated sit-to stand-to-sit transitions. Chair rise time will be determined on a standard, armless chair with the subject holding arms across the chest. Timing for this task will be obtained through a precision timing apparatus activated by the subject rising from the chair and stopped by the subject coming to rest following the last repetition..
6. **Lift and Lower Measure** - As a measure of upper body function, a lift and lower task will be performed in which subjects are instructed to lift a weighted basket (equivalent to 15 percent of body weight) from a shelf positioned at standard desk height (78.5 cm) and place it on a shelf positioned at their respective shoulder height, then to a shelf positioned at their respective head height and then to lower it back down in the reverse sequence. Subjects repeat this sequence as many times as possible in 1 minute and the number of shelves completed is recorded.
7. **Balance** - Static balance, dynamic balance, and limits of stability can be assessed using Bertec balance plates. Bertec's 3-component balance plates are computer integrated and measure vertical force and the center of pressure. Handrails and an overhead harness are provided to insure participant safety.
8. **Patient-Reported Functional Limitations Assessment (PFA-CAT)** - The MPPFc can provide investigators with standardized patient-reported functional assessment instruments using computer adaptive testing methods (CAT). This is a contemporary approach to collecting patient-reported functional outcome data that reduces response burden and data collection costs over traditional patient-reported surveys. The PFA-CAT captures three domains: 1) Physical & Movement Activities, 2) Personal Care & Instrumental Activities, and 3) Applied Cognitive. The demonstrated advantages of the PAC-CAT instrument are: reduced respondent burden, increased score precision, elimination of ceiling and floor effects, patient specific confidence intervals, monitoring of data quality in real time, and lower data collection costs.

Assessment of Physical Activity

Habitual physical activity can be monitored using ActiGraph Triaxial Accelerometers (Actigraph, Pensacola, FL). The sum of acceleration changes in the anterior-posterior, medial-lateral and vertical axes can be measured 30 times per second. A microprocessor in the accelerometer calculates and stores the number of activity counts recorded over one-minute sampling intervals (epochs). Subjects are instructed to wear the accelerometer on an elastic belt over their left or right hip while awake and will be provided a log to record their compliance. Activity counts, activity intensity and many related variables can be calculated and reported. A number of questionnaires also exist to quantify physical activity levels in various cohorts. The MPPFc, in collaboration with the Mayo Survey Research Center and Energy Balance Core, can offer a number of these instruments to interested investigators.