



# CREW STRENGTH TRAINING

## Learning Objectives

Students will

- perform body-weight squats and push-ups to develop upper and lower body strength in muscles and bones.
- record observations about improvements in strength training during this physical experience in the Mission Journal.

## Introduction

NASA researchers are working to lessen muscle atrophy and loss of bone density in astronauts involved in prolonged space flights. Both of these physical changes can be hazardous to astronauts on an extended exploration mission. Injured or weak crew members may not be able to perform their assigned tasks, causing safety concerns for themselves, as well as fellow astronauts. All crew members need to be in top physical condition to ensure the completion of the mission.

Astronauts also need strong muscles and bones to perform tasks while exploring a lunar or Martian surface. They must be able to lift, bend, build, maneuver and even exercise during a mission. Both the moon and Mars have enough gravitational force to require strong muscles and bones to do these tasks. If a crew member happens to trip and fall, the strength of their muscles and bones can mean the difference between getting up and returning to work, or having to end the mission and return back to Earth.

On Earth, the strength of muscles and bones is important to being physically fit and healthy. Severe muscle atrophy or bone loss in space could mean a crew member might fail to recover his or her pre-flight physical condition back on Earth. Therefore, astronauts do regular exercise and strength training before, during, and after a mission to keep their muscles and bones strong.

Performing multi-joint weight-bearing exercises, such as the push-up for upper body strength and the squat for lower body strength, can help develop stronger muscles and bones. Use the information below to help administer the Fit Explorer Mission Handout and help your students **train like an astronaut**.

## Administration

Follow the outlined procedure in the Crew Strength Training Mission Handout. The duration of this physical activity can vary, but will average **15 minutes**. In order for students to perform at their maximum potential, positive reinforcement should be used throughout the activity.

## Location

This physical activity should be conducted on a flat, dry surface.

*The use of a closely placed metronome may assist small groups in keeping cadence in the repetitions.*

## Set-up

Students should be at least an arms length apart from each other.

## Equipment

- Mission Journal and pencil

Optional equipment:

- watch or stopwatch
- wall access
- metronome

*For physical activity, students should wear loose-fitting clothing that permits freedom of movement.*

## Safety

- Push-ups should be done with arms extended (but not locked), and level with chest. If the student is unable to do a standard push-up, have him/her begin with bent-knee push-ups (knees on the ground).
- Always stress proper technique while performing exercises. Improper technique can lead to injury.
- Proper hydration is important before, during and after any physical activity.
- Be aware of the signs of overheating.
- A warm-up/stretching and cool-down period is always recommended.

*For information regarding warm-up/stretching and cool-down activities, reference the *Get Fit and Be Active Handbook (ages 6-17)* from the President's Council on Physical Fitness and Sports at <http://www.presidentschallenge.org/pdf/getfit.pdf>.*

## Monitoring/Assessment

Ask the Mission Question before students begin the physical activity. Have students use descriptors to verbally communicate their answers.

Use the following open-ended questions **before, during and after** practicing the physical activity to help students make observations about their own physical fitness level and their progress in this physical activity:

- How do you feel?
- How many repetitions did you do?
- How did your upper body/lower body feel during the repetitions?
- What do your arms and legs feel like now compared to when we first tried this physical activity together?
- On the moon or Mars, do you think you would feel the same way?
- Where is the energy you are using coming from?
- What muscles do you feel you are working?

The most appropriate answers would include:

- Body weight squat
  - lower back
  - buttocks
  - front/back of upper legs
  - lower legs
- Push-up
  - chest

- shoulders
- back of upper arms
- lower arms

Some quantitative data for this physical activity may include:

- rate of perceived exertion (on a scale of 1-10)
- how many correct repetitions were performed
- length of rest period
- respirations (breaths per minute)

Some qualitative data for this physical activity may include:

- technique performance
- identifying soreness in body parts
- identifying shakiness or muscle cramping

### **Collecting and Recording Data**

Students should make observations about their physical experience training for stronger muscles and bones in their Mission Journal before and after the physical activity. They should also record their physical activity goals and enter qualitative data for drawing conclusions.

- Monitor student progress throughout the physical activity by asking open-ended questions.
- Time should be allotted for the students to record observations about their experience in their Mission Journal before and after the physical activity.
- Graph the data collected in the Mission Journal on the graph paper provided, letting students interpret the data individually. Share graphs with the group.

### **Fitness Accelerations**

- Complete five squats, holding the last squat for 30 seconds. Complete five more squats, holding the last squat for 60 seconds. Rest for 60 seconds. Do this three times for a total of 30 squats.
- Complete 10-25 pushups on a balance ball. You will balance your body on the exercise ball and push off with your hands to complete the pushups.
- Grab two 1-3 lb dumb bells. Get into the push up position and do five push ups as your hands balance on the dumb bells. Now, lift the dumb bell with your right arm off the floor and bring it to your underarm. You will be balancing your body in the push up position using one arm at this point as you lift your right hand with the dumb bell to your underarm. Do these ten times, now do the same exercise with the opposite arm. *Have the students do this exercise on a padded mat.*

### **National Standards**

National Physical Education Standards:

- Standard 1: Demonstrates competency in motor skills and movement patterns needed to perform a variety of physical activities.
- Standard 2: Demonstrates understanding of movement concepts, principles, strategies, and tactics as they apply to the learning and performance of physical activities.

- Standard 3: Participates regularly in physical activity.
- Standard 4: Achieves and maintains a health-enhancing level of physical fitness.
- Standard 5: Exhibits responsible personal and social behavior that respects self and others in physical activity settings
- Standard 6: Values physical activity for health, enjoyment, challenge, self-expression, and/or social interaction.

National Health Education Standards (NHES) Second Edition (2006):

- Standard 1: Students will comprehend concepts related to health promotion and disease prevention to enhance health.
  - 1.5.1 Describe the relationship between healthy behaviors and personal health.
- Standard 4: Students will demonstrate the ability to use interpersonal communication skills to enhance health and avoid or reduce health risks.
  - 4.5.1. demonstrate effective verbal and non-verbal communication skills to enhance health.
- Standard 5: Students will demonstrate the ability to use decision-making skills to enhance health.
  - 5.5.4 Predict the potential outcomes of each option when making a health-related decision.
  - 5.5.6 Describe the outcomes of a health-related decision.
- Standard 6: Students will demonstrate the ability to use goal-setting skills to enhance health.
  - 6.5.1 Set a personal health goal and track progress toward its achievement.
- Standard 7: Students will demonstrate the ability to practice health-enhancing behaviors and avoid or reduce health risks.
  - 7.5.2 Demonstrate a variety of healthy practices and behaviors to maintain or improve personal health.
- Standard 8: Students will demonstrate the ability to advocate for personal, family and community health.
  - 8.5.1 Express opinions and give accurate information about health issues.

## National Initiatives and Other Policies

Supports the *Local Wellness Policy*, Section 204 of the Child Nutrition and WIC Reauthorization Act of 2004 and may be a valuable resource for your Student Health Advisory Council in implementing nutrition education and physical activity.

## Resources

For more information about space exploration, visit [www.nasa.gov](http://www.nasa.gov).

To learn about exercise used during past and future space flight missions, visit <http://hacd/jsc.nasa.gov/projects/ecp.cfm>.

Access fitness-related information and resources at [www.fitness.gov](http://www.fitness.gov).

View programs on health and fitness:

Scifiles™ The Case of the Physical Fitness Challenge  
<http://www.knowitall.org/nasa/scifiles/index.html>.

NASA Connect™ Good Stress: Building Better Bones and Muscles  
<http://www.knowitall.org/nasa/connect/index.html>.

For guidelines for fluid replacement and exercise:

National Athletic Trainer's Association (NATA)

- Fluid Replacement for Athletes (Position Statement)  
<http://www.nata.org/statements/position/fluidreplacement.pdf>

For information on warm-up and cool-down stretches, visit:

American Heart Association (AHA)

- Warm-up and Cool-down Stretches  
<http://americanheart.org/presenter.jhtml?identifier=3039236>

For information about rate of perceived exertion (RPE), visit:

Centers for Disease Control and Prevention (CDC)

- Perceived Exertion  
[http://www.cdc.gov/nccdphp/dnpa/physical/measuring/perceived\\_exertion.htm](http://www.cdc.gov/nccdphp/dnpa/physical/measuring/perceived_exertion.htm)

## Credits and Career Links

Lesson development by the NASA Johnson Space Center Human Research Program Education and Outreach team. Special thanks to the subject matter experts who contributed their time and knowledge to this project.

*National Aeronautics and Space Administration (NASA) contributors:*

David Hoellen, MS, ATC, LAT

Bruce Nieschwitz, ATC, LAT, USAW

Astronaut Strength, Conditioning & Rehabilitation (ASCR) Specialists  
NASA Johnson Space Center

Daniel L. Feedback, Ph.D.

Head, Muscle Research Laboratory  
Space Shuttle and Space Station Mission Scientist  
NASA Johnson Space Center

R. Donald Hagan, Ph.D.

Exercise Lead, Human Adaptation and Countermeasures Office  
Manager, Exercise Physiology Laboratory  
NASA Johnson Space Center  
<http://exploration.nasa.gov/articles/issphysiology.html>

Jean D. Sibonga, Ph.D.

Science Lead, Bone and Mineral Laboratory  
NASA Johnson Space Center  
<http://www.dsls.usra.edu/sibonga.html>

Linda H. Loerch, M.S.

Manager, Exercise Countermeasures Project  
NASA Johnson Space Center  
<http://hacd.jsc.nasa.gov/projects/ecp.cfm>

*President's Council on Physical Fitness and Sports (PCPFS) contributors:*

Thom McKenzie, Ph.D.

President's Council on Physical Fitness and Sports Science Board Member  
Emeritus Professor of Exercise and Nutritional Sciences at San Diego State University  
[http://www.presidentschallenge.org/advocates/science\\_board.aspx#Thom](http://www.presidentschallenge.org/advocates/science_board.aspx#Thom)

Christine Spain, M.A.

Director, Research, Planning, and Special Projects  
President's Council on Physical Fitness and Sports, Washington, D.C.