

The effect of a single large protein meal versus multiple smaller meals on muscle protein synthesis and protein metabolism

Submission date 01/03/2025	Recruitment status No longer recruiting	<input type="checkbox"/> Prospectively registered <input checked="" type="checkbox"/> Protocol
Registration date 06/03/2025	Overall study status Completed	<input type="checkbox"/> Statistical analysis plan <input type="checkbox"/> Results
Last Edited 04/12/2025	Condition category Nutritional, Metabolic, Endocrine	<input type="checkbox"/> Individual participant data <input checked="" type="checkbox"/> Record updated in last year

Plain English summary of protocol

Background and study aims

Skeletal muscle is important for movement and overall health. We make and break down the protein in our muscles all the time. The two main things we do that affect the processes of making new and breaking down old muscle proteins are eating (providing our body with new protein) and performing exercise, like weightlifting. Resistance exercise training (RET) (i.e. weightlifting) is a potent stimulus for increasing the process of making new muscle proteins, or what we call muscle protein synthesis (MPS). When we consume protein after weightlifting, we make even more new muscle protein.

Many research studies have shown that a protein dose of ~20-25 g maximally stimulates MPS, and any extra protein consumed above this does not get used to make new muscle proteins but instead gets broken down. However, a recent study concluded that the ingestion of 100 g of protein at a single meal (so-called one-meal a day [OMAD] style feeding) provides a larger and more sustained MPS response compared to 25 g of protein. We propose that a per-meal paradigm is correct and that even 100g OMAD is not as effective as three evenly distributed meals. Therefore, the purpose of this study is to compare the MPS response between a single high-dose protein bolus and a split feeding (three meals per day) protocol following RET in both male and female participants.

Who can participate?

Healthy male and female volunteers aged 18-30 years

What does the study involve?

The study involves four laboratory visits. On the third visit, you will consume either a single high-dose protein bolus or follow the split feeding pattern (three meals per day). You will stay in the laboratory for 17 hours, during which time we will take muscle biopsies, blood samples, and breath samples.

What are the possible benefits and risks of participating?

There are no proposed benefits to you as the subject of this study. However, the findings of this study may contribute to the development of nutritional guidelines that maximize muscle health.

As with any research, there are risks associated with participating, such as during blood sampling or muscle biopsies. The research team has done everything possible to mitigate these risks and will gladly provide further information if requested.

Where is the study run?

McMaster University in Hamilton, Ontario, Canada

When is the study starting, and how long is it expected to run for?

October 2024 to October 2025

Who is funding the study?

Natural Sciences and Engineering Research Council of Canada (NSERC)

Who is the main contact?

Dr Stuart Phillips, phillis@mcmaster.ca

Contact information

Type(s)

Scientific, Principal investigator

Contact name

Dr Stuart Phillips

ORCID ID

<https://orcid.org/0000-0002-1956-4098>

Contact details

1280 Main Street West
Department of Kinesiology
McMaster University
Hamilton
Canada
L8S4K1
+1 (905) 525-9140 ext. 24465
phillis@mcmaster.ca

Type(s)

Public

Contact name

Ms Dominique Greyvenstein

ORCID ID

<https://orcid.org/0009-0003-4717-4331>

Contact details

1280 Main Street West
Department of Kinesiology
McMaster University
Hamilton

Canada
L8S4K1
+1 (905)-525-9140 Ext. 21918
greyvend@mcmaster.ca

Type(s)

Public

Contact name

Mr James Newbold

ORCID ID

<https://orcid.org/0009-0001-1223-6198>

Contact details

1280 Main Street West
Department of Kinesiology
McMaster University
Hamilton
Canada
L8S4K1
+1 (905)-525-9140 Ext. 21918
newboldj@mcmaster.ca

Additional identifiers

Clinical Trials Information System (CTIS)

Nil known

ClinicalTrials.gov (NCT)

Nil known

Protocol serial number

18273

Study information

Scientific Title

A comparison of the muscle protein synthetic response to single bolus or split feeding following whole-body resistance exercise

Acronym

BSPF

Study objectives

1. The single-feed (bolus) group will show a plateau in muscle protein synthesis (MPS) compared to the multiple-feeding group.
2. The multiple-feeding group will exhibit a greater net protein balance over the day compared to the single-feed group.

Ethics approval required

Ethics approval required

Ethics approval(s)

approved 31/01/2025, Hamilton Integrated Research Ethics Board (293 Wellington St. N., Suite 120, Hamilton, L8L8E7, Canada; +1 (0)905-521-2100 Ext. 42013; eREBhelpdesk@hhsc.ca), ref: #18273

Study design

Single-centre interventional randomized controlled trial

Primary study design

Interventional

Study type(s)

Efficacy

Health condition(s) or problem(s) studied

Healthy young adults, exercise and protein feeding

Interventions

Participants will be randomized (by a researcher not involved in data collection) to consume 1.6 g protein/kg body weight in one meal or the same quantity split evenly between three meals. Participants will stay in the laboratory for ~17 hours.

Participants will be randomized by an outside researcher (not involved in data collection) using computer-generated random numbers to either a single bolus or a split bolus group. The outside researcher will be given the participants' weight, height, lean body mass, and body fat percentage. Given these values, the two dietary groups will have relatively similar participant anthropometric measurements (i.e. one participant in the single bolus group will be anthropometrically similar, to the best of the outside researcher's ability, as another participant in the split meal group).

Intervention Type

Mixed

Primary outcome(s)

Skeletal muscle fractional protein synthetic rate, amino acid profiles, ureagenesis, and isotope enrichment, measured by deuterated water and stable amino acid isotope incorporation of samples obtained during the 17-hour infusion at baseline (0500), 0730, 1230, 1700, 2200, and the following morning at 0500

Key secondary outcome(s)

1. Skeletal muscle free amino acid concentrations measured by mass spectrometry of samples obtained during the 17-hour infusion at baseline (0500), 0730, 1230, 1700, 2200, and the morning after at 0500. Plasma amino acid concentrations are measured by mass spectrometry from samples obtained during the 17-hour infusion at 30-minute intervals starting at 0500, and finishing at 2200, as well as one sample the following morning at 0500.
2. Proteins of interest from muscle measured using histological staining of samples obtained during the 17-hour infusion at baseline (0500), 0730, 1230, 1700, 2200, and the following morning at 0500.

3. Amino acid oxidation measured using breath sampling during the 17-hour infusion at 30-minute intervals starting at 0500, and finishing at 2200, as well as one sample the following morning at 0500. Amino acid oxidation in the form of ureagenesis is measured using urine samples during the 17-hour infusion at 0500, 1700, and the following morning at 0500.
4. Muscle protein expression measured using western blotting for samples obtained during the 17-hour infusion at baseline (0500), 0730, 1230, 1700, 2200, and the following morning at 0500.
5. Gastrointestinal comfort measured using the daily bowel function questionnaire, appetite visual analogue scale questionnaire, and the gastrointestinal tolerance questionnaire throughout the 17-hour infusion day at 0500, 0830, 1330, 1800, and the following morning at 0500.

Completion date

04/10/2025

Eligibility

Key inclusion criteria

1. English-speaking
2. Male or Female, aged 18-30 years
3. Healthy, non-smoking/vaping
4. BMI between 20 and 30 kg/m²
5. Not taking any medication or with any medical condition that, in the opinion of the investigators, would compromise the study outcome or the safety of the research participant. For example, taking any corticosteroids or antibiotics and individuals with any metabolic disorders like diabetes.
6. No contraindications to proteins provided – whey, pea, soy, egg – in meals
7. Ability to provide informed consent

Participant type(s)

Healthy volunteer

Healthy volunteers allowed

No

Age group

Adult

Lower age limit

18 years

Upper age limit

30 years

Sex

All

Total final enrolment

24

Key exclusion criteria

1. Subject has any concurrent medical, orthopedic, or psychiatric requirements that, in the opinion of the investigators, would compromise their ability to comply with the study requirements
2. Allergy or sensitivity to study ingredients
3. Individuals who are incompetent and/or who are unable to give informed consent
4. Any other condition that, in the opinion of the investigators, may adversely affect the subject's ability to complete the study or its measures or may pose a significant risk to the subject
5. Any cancer, or related condition, or any genetic muscle diseases or disorders
6. Current gastrointestinal disorder that could interfere with the study (e.g., IBS/IBD, diarrhea, acid reflux disease, dysphagia, etc.)
7. Excessive alcohol consumption (>21 units/week) and/or a smoker (cigarettes or vaping)
8. Use of corticosteroids, antibiotics, any anabolic steroid, creatine, whey protein supplements, casein, branched-chain amino acids (BCAAs) or any other natural health product (NHP), medication or supplement used for muscle strengthening/building within 45 days prior to screening
9. Personal or family history of a clotting disorder or deep vein thrombosis

Date of first enrolment

14/02/2025

Date of final enrolment

30/09/2025

Locations

Countries of recruitment

Canada

Study participating centre

McMaster University

1280 Main Street West

Hamilton

Canada

L8S4L8

Sponsor information

Organisation

McMaster University

ROR

<https://ror.org/02fa3aq29>

Funder(s)

Funder type

Government

Funder Name

Natural Sciences and Engineering Research Council of Canada

Alternative Name(s)

Conseil de Recherches en Sciences Naturelles et en Génie du Canada, The Natural Sciences and Engineering Research Council of Canada, nserc_crsng, NSERC, CRSNG

Funding Body Type

Government organisation

Funding Body Subtype

National government

Location

Canada

Results and Publications

Individual participant data (IPD) sharing plan

The data-sharing plans for the current study are that all data will be made publically available upon reasonable request from the PI Dr Stuart Phillips (phillis@mcmaster.ca).

IPD sharing plan summary

Available on request

Study outputs

Output type	Details	Date created	Date added	Peer reviewed?	Patient-facing?
Protocol file			06/03/2025	No	No