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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

Registration date
06/03/2025

Overall study status
Completed

Last Edited
04/12/2025

Condition category
Nutritional, Metabolic, Endocrine

[_] Prospectively registered
[X] Protocol
[_] Statistical analysis plan
[_] Results
[_] Individual participant data
[X] 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

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Scientific, Principal investigator

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Additional identifiers

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

Primary study design
Interventional

Study design
Single-centre interventional randomized controlled trial

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