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# Evaluation of the relationship between maximal aerobic capacity and metabolic flexibility in response to fasting glucose/insulin in humans (Evaluación de la relación entre la capacidad aeróbica máxima y flexibilidad metabólica en respuesta a ayuno prolongado e infusión de glucosa/insulina en humanos)

**Submission date**
13/10/2017

**Recruitment status**
No longer recruiting

**Registration date**
31/10/2017

**Overall study status**
Completed

**Last Edited**
09/06/2020

**Condition category**
Nutritional, Metabolic, Endocrine

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

## Plain English summary of protocol

Background and study aims
Humans get energy from different fuels that basically correspond to carbohydrates (e.g. sugar), fats (e.g. oil) and proteins (e.g. meat). Depending on the state of food (fasting or post-meal), the body must adjust the use of these fuels to the presence of these in food. So, every time breakfast is eaten, the body must increase the use (oxidation) of carbohydrates and decrease that of fats. During sleep the body gradually increases the oxidation of fats and reduces that of carbohydrates. This is called metabolic flexibility. It has been proposed that lower metabolic flexibility predisposes to metabolic alterations, including insulin resistance. The aim of this study is to compare the metabolic flexibility in two conditions: prolonged fasting and infusion of glucose and insulin.

Who can participate?
Healthy men aged 18 to 35

What does the study involve?
The study includes three sessions. Participants are randomly allocated to one of two groups, to determine which of the sessions is first. Participants have to come at 8:00 in the morning to start the tests. The sessions are performed with breaks of 7 days. The participant must attend 2-3 hours after his last meal, and his maximum aerobic capacity (oxygen consumption) is measured while exercising. In addition, a catheter (tube) is inserted into the vein of an arm to obtain blood samples during exercise. The amount of blood extracted is 30 ml in total, equivalent to 2 tablespoons. The following sessions (session of prolonged fasting and session of infusion of

glucose and insulin) take place with an interval of 7 days. At the
prolonged fasting session the participant should be fasting, a catheter is inserted into the vein of each arm, and the amount of energy that the body spends (metabolic rate) is measured by installing a plastic capsule over their head for 20 minutes to measure their breathing. Two blood samples of 30 ml in total, equivalent to 2 tablespoons, are taken. After 8 hours of rest, the metabolic rate measurement is repeated and two blood samples are taken. Once this procedure is completed, the catheter is removed, and lunch is delivered. At the glucose and insulin infusion session the participant should be fasting, a catheter is inserted into the vein of each arm and the metabolic rate is measured. Two blood samples of 30 ml in total, equivalent to 2 tablespoons, are taken. Participants are infused with glucose and insulin for 2 hours. During the procedure, a blood sample is taken every 5 minutes to check the amount of sugar in the blood. Additional blood samples are taken at 90, 100, 110 and 120 minutes after starting the infusion. The metabolic rate is measured, and once this procedure is completed, the catheter is removed and lunch is delivered

What are the possible benefits and risks of participating?
There is no immediate direct benefit to those taking part, but the information obtained will be useful to know more about the metabolic alterations usually associated with excess weight. The results of the tests will be delivered to the participants.

Where is the study run from?
Pontifical Catholic University of Chile

When is the study starting and how long is it expected to run for?
June 2017 to January 2018

Who is funding the study?
CONICYT - Fondecyt Regular 2017

Who is the main contact?
Dr José Galgani
jgalgani@uc.cl

# Contact information

### Type(s)
Scientific

### Contact name
Dr Jose Galgani Fuentes

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# Additional identifiers

### Protocol serial number
1170117

# Study information

### Scientific Title
Evaluation of the relationship between maximal aerobic capacity and metabolic flexibility in response to fasting glucose/insulin in humans

### Acronym
FAST

### Study objectives
The metabolic flexibility to glucose and fatty acids is directly associated with mitochondrial functionality being a predictor of metabolic flexibility.

### Ethics approval required
Old ethics approval format

### Ethics approval(s)
Ethics Board at Pontificia Universidad Católica de Chile, 08/06/2017, ref: 1170117

### Study design
Interventional single-center randomized crossover trial

### Primary study design
Interventional

### Study type(s)
Other

### Health condition(s) or problem(s) studied
Metabolic flexibility and maximal aerobic capacity in healthy subjects

### Interventions
In the selected individuals, the maximum aerobic capacity (by indirect calorimetry) and lactate threshold (by concentration in lactate venous blood) in an exercise bicycle will be determined. On a second visit (4-7 days later), subjects will be randomly allocated to undergo either a 20-hour fasting session or a hyperinsulinemic, euglycemic clamp session. 10 volunteers will be assigned randomly to the fasting session for their first measurement and 10 will be assigned to the clamp session for their first measurement. The exercise session will be held before or after, but all volunteers must complete all three sessions.

In the fasting session, an intravenous line will be placed in the vein of an arm. After 30 minutes of rest and 12 hours of fasting, the gas exchange will be evaluated for 20 min by indirect calorimetry. During the measurement two blood samples (glucose, lactate, free fatty acids, triglycerides, VLDL, 3-OH-butyrate and insulin) will be extracted with an interval of 10 min

between them. At the end of the calorimetric measurement the line will be removed, and the volunteer will remain at rest for 7 hours. At the end of the rest, an intravenous line will be installed and the calorimetric measurement will be performed for 20 min. During this period two blood samples (glucose, lactate, free fatty acids, triglycerides, VLDL, 3-OH-butyrate and insulin) will be extracted with an interval of 10 min between them.

In the euglycemic-hyperinsulinemic clamp session, individuals will attend under nighttime fasting conditions. An intravenous line will be installed in both arms. After 30 minutes of absolute rest and 12 hours of fasting, the gas exchange will be evaluated for 20 min by indirect calorimetry. During the measurement two blood samples (glucose, lactate, free fatty acids, triglycerides, VLDL, 3-OH-butyrate and insulin) will be extracted with an interval of 10 min between them. Insulin (80 mU/m2/min) will then be infused for 2 hours, along with a variable glucose infusion, which will be sufficient to maintain glycemia at 90 mg/dl. During the last 20 min of the infusion, the gas exchange measurement will be repeated, and three blood samples (glucose, lactate, free fatty acids, triglycerides, VLDL, 3-OH-butyrate and insulin) will be extracted with an interval of 10 min between them.

### Intervention Type
Other

### Primary outcome(s)
1. Resting metabolic rate and respiratory quotient, measured by indirect calorimetry at two of three sessions with an interval of 4-7 days during the month following the selection
2. Glucose metabolic flexibility, measured by euglycemic-hyperinsulinemic clamp
3. Maximal aerobic capacity, measured by indirect calorimetry and a blood sample for lactate concentration in venous blood during exercise for 15 minutes. This measurement is performed during the month following the selection

### Key secondary outcome(s))
1. Glucose, lactate, free fatty acids, triglycerides, VLDL, 3-OH-butyrate and insulin concentration, measured by taking two blood samples with a 10-minute interval before and after the clamp
2. Body mass and body composition, measured using the body mass index formula (BMI) and electrical bioimpedance

### Completion date
08/01/2018

## Eligibility

### Key inclusion criteria
1. Healthy men (by physical examination, past and current medical history, and routine blood testing, including biochemical profile, thyroid-stimulating hormone, free thyroxine, electrolytes, creatinine, and hemogram)
2. Between 18 and 35 years old
3. IMC: 18.5 – 25 kg/m2
4. Stable body weight (change<2 kg over the past 3 months)
5. Physical activity (<3 days/week)
6. Do not take medications

### Participant type(s)
Healthy volunteer

**Healthy volunteers allowed**
No

**Age group**
Adult

**Lower age limit**
18 years

**Sex**
Male

**Total final enrolment**
18

**Key exclusion criteria**
1. Men with any disease
2. Younger than 18 years old and older than 35 years old
3. Unstable weight (change>2 kg over the past 3 months)
4. Physical activity (>3 days/wk)
5. Taking medications

**Date of first enrolment**
12/09/2017

**Date of final enrolment**
20/10/2017

# Locations

**Countries of recruitment**
Chile

**Study participating centre**
**Pontificia Universidad Católica de Chile. Departamento de Nutrición, Diabetes y Metabolismo**
Alameda 340, interior, 2° patio, 4° Piso
Santiago
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# Sponsor information

**Organisation**
Fondecyt

**ROR**
https://ror.org/02ap3w078

# Funder(s)

**Funder type**
University/education

**Funder Name**
Pontificia Universidad Católica de Chile (Santiago)

# Results and Publications

**Individual participant data (IPD) sharing plan**
The datasets generated during and/or analysed during the current study are/will be available upon request from Dr José Galgani (jgalgani@uc.cl).

**IPD sharing plan summary**
Available on request

**Study outputs**

| Output type | Details | Date created | Date added | Peer reviewed? | Patient-facing? |
|---|---|---|---|---|---|
| Results article | results | 01/06/2020 | 09/06/2020 | Yes | No |
| Basic results | | 25/01/2019 | 25/01/2019 | No | No |
| Participant information sheet | Participant information sheet | 11/11/2025 | 11/11/2025 | No | Yes |