Submission ID #: 67864
Scriptwriter Name: Debopriya Sadhukhan
Project Page Link: https://review.jove.com/account/file-uploader?src=20698568

Title: Assessment of Physical Activity Intensity with Accelerometers and Oxygen Consumption

Authors and Affiliations:

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Author Questionnaire

1. **Microscopy**: Does your protocol require the use of a dissecting or stereomicroscope for performing a complex dissection, microinjection technique, or something similar? **NO**

2. **Software:** Does the part of your protocol being filmed include step-by-step descriptions of software usage? **YES**

Videographer: Record the screen for the SCREEN shots as a backup

3. **Filming location:** Will the filming need to take place in multiple locations? **NO**

Current Protocol Length
Number of Steps: 23
Number of Shots: 49

Introduction

Videographer: Obtain headshots for all authors available at the filming location.

REQUIRED:

1.1. **Marcelo Cano-Cappellacci:** This research investigates the level of agreement between accelerometer data from the waist and wrist and oxygen consumption assessments.

1.1.1. INTERVIEW: Named Talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B-roll: LAB MEDIA: Figure 4.* Videographer's NOTE: Video file: A005C0155_20250513114025_0001, Audio file: TASCAM_0174.

What are the most recent developments in your field of research?

1.2. **Magdalena Vega:** Recent findings show that physical activity intensity is critical for achieving health benefits. However, the same walking speed may represent different intensities depending on an individual's physical fitness.

1.2.1. INTERVIEW: Named Talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B-roll: 3.4.1.* Videographer's NOTE: Video file: A005C0156_20250513114237_0001, Audio file: TASCAM_0175.

What are the current experimental challenges?

1.3. **José Fernández:** A major experimental challenge is tailoring exercise interventions to match the physical fitness levels of individuals with different non-communicable diseases. This poses significant difficulties for health professionals.

1.3.1. INTERVIEW: Named Talent says the statement above in an interview-style shot, looking slightly off-camera. Videographer's NOTE: Video file: A005C0157_20250513114416_0001 Audio file: TASCAM_0177

What research gap are you addressing with your protocol?

1.4. **Magdalena Vega:** This research addresses the gap in identifying ventilatory threshold 1—the gold standard for defining the onset of vigorous physical activity—during an incremental walking-jogging test, and compares it to accelerometer recordings.

1.4.1. INTERVIEW: Named Talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B-roll: 5.1.1., 5.1.2., 5.1.3.*
Videographer's NOTE: Video file: A005C0158_20250513114556_0001 Audio file: TASCAM_0178

What advantage does your protocol offer compared to other techniques?

1.5. **José Fernández:** This protocol combines oxygen consumption, the laboratory gold standard for assessing physical activity intensity, with accelerometer recordings, the most commonly used field method to objectively assess it. It reveals substantial differences in accelerometer data at the highest walking speeds.

1.5.1. INTERVIEW: Named Talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B-roll: LAB MEDIA: Figure 4*
Videographer's NOTE: Video file: A005C0163_20250513115206_0001 Audio file: TASCAM_0183

Videographer: Obtain headshots for all authors available at the filming location.

Testimonial Questions:

How do you think publishing with JoVE will enhance the visibility and impact of your research?

1.6. **Marcelo Cano-Cappellacci:** We believe that publishing this protocol in JoVE will increase the visibility of our research.

1.6.1. INTERVIEW: Named Talent says the statement above in an interview-style shot, looking slightly off-camera. Videographer's NOTE: A005C0164_20250513115532_0001 Audio file: TASCAM_0184

Can you share a specific success story or benefit you've experienced—or expect to experience—after using or publishing with JoVE?

1.7. **Marcelo Cano-Cappellacci:** With this video published with JoVE, we hope to shorten training time for the use of the ergoespirometer and accelerometer devices, making the learning process more efficient for new users.

1.7.1. INTERVIEW: Named Talent says the statement above in an interview-style shot, looking slightly off-camera. Videographer's NOTE: Video file: A005C0165_20250513115721_0001 Audio file: TASCAM_0185

Ethics Title Card

This research has been approved by the Committee on Ethics and Research in Human Beings of the University of Chile

Protocol

2. Equipment Setup and Calibration Procedure Prior to Testing

Demonstrator: Paulina Ibacache

Videographer: Record the screen for the SCREEN shots as a backup.

2.1. To begin, assemble the portable ergospirometer with the harness **[1]** and attach the accelerometers to the Velcro straps **[2]**. Set up the Bluetooth heart rate monitor **[3]**.

2.1.1. WIDE: A shot of the assembled portable ergospirometer and the talent placing the harness onto it. Videographer's NOTE: A005C0193_20250513145914_0001.

2.1.2. Talent securing accelerometers onto Velcro straps. Videographer's NOTE: A005C0189_20250513144558_0001

2.1.3. Talent turning on and setting up the Bluetooth heart rate monitor. Videographer's NOTE: A005C0172_20250513133517_0001

2.2. Press the **Calibrate** button on the software screen to calibrate the gases and flowmeter of the portable ergospirometer outside the walking-jogging track **[1]**. Then, press **Start Calibration Step 1** on the gas calibration window to assess the concentration of oxygen and carbon dioxide in the air **[2]**.

2.2.1. SCREEN: 2.2.1_2.2.2_2.3.2.mp4 01:26-01:33.

2.2.2. SCREEN: 2.2.1_2.2.2_2.3.2.mp4 01:34-01:44, 02:00-02:14.

2.3. Connect a gas calibration bottle to the gas analyzer line **[1]**. Press **Step 2** on the gas calibration window to assess the concentration of oxygen and carbon dioxide in the calibration bottle **[2]**.

2.3.1. Talent attaching the calibration gas bottle to the gas analyzer line. Videographer's NOTE: A005C0168_20250513122133_0001.

2.3.2. SCREEN: 2.2.1_2.2.2_2.3.2.mp4 02:35-2:45, -2:55-03:00, 03:20-03:35.

2.4. Now, connect the flow meter to a 3-liter calibration syringe **[1]**. Press **Start calibration** on the flow meter calibration window **[2]**. Move the syringe plunger through its full range for 5 cycles to reach a stable airflow **[3]**.

2.4.1. Talent connecting the 3-liter calibration syringe to the flow meter inlet.

Videographer's NOTE: 2.4.1-2.4.3 A005C0171_20250513123319_0001.

2.4.2. SCREEN: 2.4.2-jove.mp4 01:15-01:46.

2.4.3. Talent moving the syringe plunger through its full range.

2.5. Next, press **Add new participant** on the ergospirometer software and enter the participant data **[1]**. On the laptop with the accelerometer software, connect the accelerometer to a USB port **[2]**. Press **Initialize** and enter the required volunteer's data, usage time for synchronization purposes, and body placement information. Select the device sampling rate to 100 Hertz **[3]**. Unplug the accelerometer **[4]** and replace the USB cap **[5]**. NOTE: The VO for 2.5.4 has been removed.

2.5.1. SCREEN: 2.5.1-jove.mp4 00:05-00:53. *Video Editor: Blur "Doe" and "Jane" on the left side window, as this is the name of the patient.*

2.5.2. Talent connecting the accelerometer to the laptop USB port. Videographer's NOTE: A005C0191_20250513144942_0001.

2.5.3. SCREEN: 2.5.3-and-2.5.4.mkv 00:00-00:20, 00:50-00:58.

~~2.5.4. SCREEN: To be provided by authors: Clicking on **Enter Subject Information** and **Initialize 1 Device.**~~ NOTE: The authors didn't provide SCs for this shot.

2.5.5. Talent removing accelerometer. Videographer's NOTE: 2.5.5-2.5.6 A005C0192_20250513145045_0001

2.5.6. Talent replacing the USB cap.

2.6. Prepare clean masks that fit the volunteer **[1]**. After performing an air leak test, connect the selected mask to the ergospirometer **[2]**.

2.6.1. A shot of the prepared clean mask. Videographer's NOTE: A005C0175_20250513135526_0001

2.6.2. Talent connecting the mask to the ergospirometer. Videographer's NOTE: A005C0176_20250513135754_0001

2.7. Connect the heart rate monitor to the ergospirometer software **[1]**. Attach accelerometers to the right wrist and waist **[2]**, and connect the ergospirometer **[3]**. Press the **Device Setup** button to verify the connection of the ergospirometer and the Bluetooth heart rate sensor **[4]**.

2.7.1. Talent pairing the heart rate monitor to the ergospirometer software. Videographer's NOTE: SCREEN.

2.7.2. Talent securing accelerometers to the volunteer's wrist and waist. Videographer's NOTE: A005C0174_20250513134351_0001

2.7.3. Talent connecting the ergospirometer. Videographer's NOTE: A005C0173_20250513134048_0001

2.7.4. SCREEN: 2.7.4_2.8.1.mp4. 00:00-00:20.

2.8. Now, press the **Initiate Sensor Adjustment** button for ambient gas calibration **[1]**. NOTE: The VO for 2.8.2 has been removed.

2.8.1. SCREEN: 2.7.4_2.8.1.mp4 00:21-00:40, 01:20-01:26.

~~2.8.2. SCREEN: To be provided by authors: Pressing **Next** and transitioning to Wasserman panels.~~ NOTE: The authors didn't provide SCs for this shot.

2.9. Bring the participant to the starting point of the track **[1-TXT]**.

2.9.1. Talent guiding participant to the starting position. **TXT: Ensure the participant remains seated and rests for 3 min before the test begins** Videographer's NOTE: A005C0177_20250513140402_0001

2.10. Check the audio volume of the Modified Incremental Shuttle Walking Test on a mobile device to confirm it can be heard clearly by the participant **[1]**.

2.10.1. Talent playing Modified walking test audio on a mobile device. Videographer's NOTE: A005C0181_20250513140954_0001.

3. Explaining the Test to the Participant and Executing the Test

Demonstrator: Matías Briones

3.1. Instruct the participant to remain seated, avoid speaking, and breathe normally to begin the baseline measurement for the portable ergospirometer and accelerometer inactivity **[1]**.

3.1.1. Participant seated calmly in a chair, breathing normally, with no movement or speech. Videographer's NOTE: A005C0179_20250513140705_0001

3.2. Play the audio of the Modified walking test to demonstrate the speed of walking following the sound signal to cover a 10-meter track, synchronizing the speed of walking with the sound signal **[1]**.

3.2.1. Talent playing the audio of the Modified walking test to demonstrate the speed of walking following the sound signal to cover a 10-meter track, synchronizing the speed of walking with the sound signal. Videographer's NOTE: A005C0182_20250513141243_0001

3.3. Allow the participant to stand, and along with two researchers, initiate the test while stepping away from the chair to clear the path **[1]**.

3.3.1. Participant standing up, flanked by two researchers who step aside from the chair. Videographer's NOTE: A005C0183_20250513141528_0001

3.4. Have the participant start the test and help guide the participant's walking pace with the Modified walking test audio, following the incremental pace of the test until the end of the Modified walking test audio **[1]**. Press the **Start test** button on the ergospirometer software at the same time as Researcher 1, and press **Add text** at each speed increase indicated by the Modified walking test audio **[2]**.

3.4.1. Participant starting to walk along the track, guided by audio cues. Videographer's NOTE: A005C0185_20250513141939_0001

3.4.2. SCREEN: 3.4.2.A.mp4 00:14-00:28, 00:36-00:40, 01:33-01:37, 02:20-end. Then, 3.4.2.B.mp4 02:49-02:55, 06:05-06:15.

3.5. After the test concludes, instruct the participant to sit and remain silent, breathing normally for 2 minutes to finalize data capture **[1]**.

3.5.1. Participant seated again, quietly breathing, visibly resting after the test. Videographer's NOTE: A005C0186_20250513142139_0001

3.6. After 2 minutes, press the Square symbol to stop recording measurements **[1]** and begin removing all equipment from the participant, concluding data collection on the laptop in the ergospirometer software **[2]**.

3.6.1. SCREEN: 3.4.2.B.mp4 06:20-end.

3.6.2. Talent gently removing sensors, mask, and straps from the participant. Videographer's NOTE: A005C0188_20250513142326_0001

4. Data Review and Extraction Prior to Analysis

Demonstrator: Matías Briones

4.1. Review data in the ergospirometer software to ensure the collected data of oxygen consumption, exhaled carbon dioxide, and minute ventilation were reliable for the project **[1]**. Press the **Next** button followed by the **Smoothing** button to average data in 10-second intervals **[2]**.

4.1.1. SCREEN: 4.1.1-y-4.1.2.mp4 00:00-00:14.

4.1.2. SCREEN: 4.1.1-y-4.1.2.mp4 00:15-01:11. *Video Editor: Delete the pauses.*

4.2. Connect the accelerometer to the laptop using a USB cable and download data to the physical activity software **[1]**. Select an epoch length of 10 seconds when downloading the accelerometer data **[2]**.

4.2.1. Talent connecting the accelerometer to the laptop using a USB cable. NOTE: 4.2.1 is split into two shots. A005C0191_20250513144942_0001 (same video as 2.5.2) and SCREEN: 4.2.1.mkv 00:00-00:10, 00:35-00:45.

4.2.2. SCREEN: 4.2.2.mkv 00:00-00:20.

4.3. Download both accelerometer and indirect calorimetry data files and manually transcribe the information into a statistical software spreadsheet **[1]**. NOTE: The sentence numbers for the VO have been adjusted.

4.3.1. SCREEN: 4.3.1-and-4.3.2.mkv 00:00-end. NOTE: 4.3.1 and 4.3.2 are together.

~~4.3.2. SCREEN: To be provided by authors: The data being entered into a spreadsheet.~~

5. Data Analysis

Demonstrator: Marcelo Cano

5.1. In the ergospirometer software, open the Ventilatory Threshold window for each indirect calorimetry file **[1]**. Identify Ventilatory Threshold 1 from the change in the slope of the scatter plot of oxygen consumption versus carbon dioxide production **[2]**. Then, examine the carbon dioxide production versus minute ventilation scatter plot to determine Ventilatory Threshold 2 based on the increase in slope **[3]**.

5.1.1. SCREEN: 5.1.1_5.1.2_5.1.3.mkv 00:00-00:08.

5.1.2. SCREEN: 5.1.1_5.1.2_5.1.3.mkv 00:09-00:30.

5.1.3. SCREEN: 5.1.1_5.1.2_5.1.3.mkv 00:32-00:57.

5.2. Register the participant's walking speed corresponding to Ventilatory Threshold 1 and 2 in the database **[1]**.

5.2.1. SCREEN: 5.2.1.mkv 00:00-00:20.

5.3. Now, extract the count data from the wrist accelerometer log file. Transfer these counts into a spreadsheet before averaging them over the final 30 seconds of each test stage **[1]**. NOTE: The VO for 5.3.1 has been removed and the sentence numbers for the VO

have been adjusted.

~~5.3.1. SCREEN: To be provided by authors: Waist logs opened; scrolling through data. The count data being extracted.~~ NOTE: The authors didn't provide SCs for this shot.

5.3.2. SCREEN: 5.3.2-and-5.3.3.mkv 00:00-00:40. NOTE: 5.3.2 and 5.3.3 are together. Emphasize or highlight the Export button at the bottom right of the screen when the VO says "Transfer these counts into a spreadsheet before averaging them over the final 30 seconds of each test stage". Blur the patient's name "Isidora….".

~~5.3.3. SCREEN: To be provided by authors: The counts being transferred into a spreadsheet and being averaged over the final 30 seconds of each test stage.~~

5.4. Perform descriptive and inferential statistical analysis, such as Paired Student's T-Test, Intraclass Correlation Coefficient, and Cohen's D, using open-source statistical software **[1]**.

5.4.1. SCREEN: 5.4.1.mkv 01:05-02:10.

Results

6. Results

6.1. This figure presents a Bland-Altman plot comparing wrist- and waist-worn accelerometers, which revealed poor agreement in counts per minute at 3.6 kilometers per hour, indicating placement-based variability in activity measurement **[1]**.

6.1.1. LAB MEDIA: Figure 2.

6.2. Additionally, no significant correlation between counts per minute and absolute oxygen consumption was found, suggesting limited metabolic insight from accelerometer placement alone **[1]**.

6.2.1. LAB MEDIA: Figure 3.

6.3. However, both oxygen consumption and accelerometer counts per minute increased with test speed, reflecting the expected physiological response to higher exertion **[1]**.

6.3.1. LAB MEDIA: Figure 4. *Video Editor: Highlight the VO2 plot at the top (grey plot with the grey spheres) when the VO says, "oxygen consumption" and highlight the Waist and wrist plots (grey plot with the grey squares and black plot with the black triangles) when the VO says "accelerometer counts per minute".*

6.4. At higher speeds **[1]**, wrist-mounted accelerometers showed a steeper rise in counts per minute **[2]** than waist-mounted devices **[3]**, indicating potential overestimation of movement when worn on the wrist **[4]**.

6.4.1. LAB MEDIA: Figure 4.

6.4.2. LAB MEDIA: Figure 4. *Video Editor: Highlight the wrist plot (black plot with black triangles).*

6.4.3. LAB MEDIA: Figure 4. *Video Editor: Highlight the waist plot (grey plot with grey squares).*

6.4.4. LAB MEDIA: Figure 4.

Pronunciation Guides:

Ergospirometer
Pronunciation link: https://www.howtopronounce.com/ergospirometer
IPA: /ˌɜːrgoʊˈspaɪrəˌmiːtər/
Phonetic Spelling: ur-goh-spy-ruh-mee-tur
Accelerometers
Pronunciation link: https://www.merriam-webster.com/dictionary/accelerometer

IPA: /əkˌsɛləˈrɑːmɪtər/
Phonetic Spelling: ak-seh-luh-rah-muh-ter
 Ventilation
Pronunciation link: https://www.merriam-webster.com/dictionary/ventilation
IPA: /ˌvɛn(t)lˈeɪʃən/
Phonetic Spelling: ven-tuh-lay-shun
 Calorimetry (from "indirect calorimetry")
Pronunciation link: https://www.merriam-webster.com/dictionary/calorimetry
IPA: /ˌkæləˈrɪmətri/
Phonetic Spelling: kal-uh-rih-muh-tree
 Syringe
Pronunciation link: https://www.merriam-webster.com/dictionary/syringe
IPA: /səˈrɪndʒ/
Phonetic Spelling: suh-rinj
 Epoch
Pronunciation link: https://www.merriam-webster.com/dictionary/epoch
IPA: /ˈɛpək/
Phonetic Spelling: eh-puhk
 Descriptive
Pronunciation link: https://www.merriam-webster.com/dictionary/descriptive
IPA: /dɪˈskrɪptɪv/
Phonetic Spelling: dih-skrip-tiv
 Inferential
Pronunciation link: https://www.merriam-webster.com/dictionary/inferential
IPA: /ˌɪnfəˈrɛnʃəl/
Phonetic Spelling: in-fuh-ren-shul
 Cohen's D
Pronunciation link: https://www.howtopronounce.com/cohen-s-d
IPA: /ˈkoʊənz diː/
Phonetic Spelling: koh-enz dee
 Intraclass (from Intraclass Correlation Coefficient)
Pronunciation link: https://www.howtopronounce.com/intraclass
IPA: /ˈɪntrəˌklæs/
Phonetic Spelling: in-truh-klass
 Wasserman (from Wasserman panels)
Pronunciation link: https://www.howtopronounce.com/wasserman
IPA: /ˈwɑːsɚmən/
Phonetic Spelling: wah-ser-muhn