GPS Watches for Measuring Energy Expenditure during Physical Activity

Jamie M. Wise, Barron J. Orr, Kristin D. Wisneski and Nobuko Hongu

What is GPS?

The Global Positioning System (GPS) is a space-based navigational and positioning system. A network of between 24 and 32 satellites transmit continuous microwave signals to the Earth. These signals can be picked up by a GPS receiver anywhere on the Earth to calculate three-dimensional position, velocity, and time in order to determine present location.

What is Energy Expenditure?

Total energy expenditure is the amount of energy used to perform an activity. Energy expenditure, measured in calories, is the energy needed to maintain constant conditions in the body (i.e. resting energy expenditure, diet-induced thermogenesis, and the energy cost of physical activity). Your daily energy expenditure, or basal energy expenditure is the minimum amount of calories needed to survive, or the minimum number of calories one should eat each day to maintain weight.

How GPS Measures Energy Expenditure of an Individual?

For a given body weight, energy expenditure during physical activity (e.g. walking) can be determined by tracking speed, slope, and duration of physical activity. GPS technology offers benefits for assessing physical activity by tracking the exact location of individual through time. This permits the calculation of an individual’s pace (time spent in increments of physical activity) as they move both horizontally across the landscape, as well as their altitude variation (slope). These measurements can then be transformed into an estimate of energy expenditure.

GPS and fitness technology have been integrated into single devise, commonly called a GPS fitness unit or a GPS watch, which not only records location, but also computes energy expenditure (kcal/min). These GPS fitness units can track fitness progress and history and can be used during a variety of outdoor activities including: walking, hiking, running, and cycling. Here is the list of popular GPS watches available (not an exclusive list) on the market.
### GPS Fitness Units/GPS Watches on the Market:

<table>
<thead>
<tr>
<th>Company Product</th>
<th>Price†</th>
<th>SiRFstarIII chip*</th>
<th>WAAS*</th>
<th>Accessories</th>
<th>Advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garmin 305</td>
<td>$300</td>
<td>Yes</td>
<td>Yes</td>
<td>HR monitor, foot pod</td>
<td>Customizable screens, compete with past workouts</td>
</tr>
<tr>
<td>Garmin 405</td>
<td>$300</td>
<td>Yes</td>
<td>Yes</td>
<td>HR monitor, foot pod</td>
<td>Sleek look, share workouts with other users</td>
</tr>
<tr>
<td>Polar RS800G3</td>
<td>$470</td>
<td>Yes</td>
<td>Yes</td>
<td>HR Monitor, GPS, USB adapter, ProTrainer 5 software included</td>
<td>Geared towards fitness</td>
</tr>
<tr>
<td>ADEO fitness trainer motionlingo</td>
<td>$150</td>
<td></td>
<td></td>
<td>Works with MP3/iPod</td>
<td>Designed to enhance a physically active lifestyle, compatible with Google Earth</td>
</tr>
<tr>
<td>Suunto Multi-Sport Pack, t3</td>
<td>$320</td>
<td></td>
<td></td>
<td>Includes HR belt, GPS Pod</td>
<td>Useful for a variety of outdoor activities</td>
</tr>
</tbody>
</table>

*Note: The SiRFstarIII chip and WAAS (Wide Area Augmentation System) have increased a GPS receiver’s ability to communicate with the orbiting satellites that provide a user with their location. The advantages of this latest technology are 1) faster location identification and 2) higher sensitivity for locking onto satellite signals in areas under dense foliage or in urban canyons or near skyscrapers.

†Prices are subject to change.

### Pros & Cons of GPS Fitness Units/GPS Watches

Building from evidence that GPS technology has potential to enhance accuracy of measurement of outdoor physical activity, four GPS fitness units/watches were tested at three different speeds (3, 5, & 7 km/hr). Three GPS watches were worn on the wrists, while the ADEO was placed on the arm. These were compared against an RT 3 accelerometer (a validation tool for the assessment of physical activity) and pedometer worn on the waist. All units were worn simultaneously during trials on an outdoor 400 meter track. The pros and cons observed for each unit compared are noted below:

<table>
<thead>
<tr>
<th>Company Product</th>
<th>Pros</th>
<th>Cons</th>
<th>Manufacturer’s website</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garmin 305</td>
<td>User friendly, audible alerts</td>
<td>Bulky frame</td>
<td><a href="http://www.garmin.com">www.garmin.com</a></td>
</tr>
<tr>
<td>Polar RS800G3</td>
<td>Good EE measurement</td>
<td>Downloading procedure not user friendly</td>
<td><a href="http://www.polarusa.com">www.polarusa.com</a></td>
</tr>
<tr>
<td>ADEO fitness trainer motionlingo</td>
<td>Frequent audio updates, customizable workouts, ipod connection</td>
<td>Less accurate EE measurement</td>
<td><a href="http://www.motionlingo.com">www.motionlingo.com</a></td>
</tr>
<tr>
<td>Suunto Multi-Sport Pack, t3</td>
<td>Download/workout view on computer</td>
<td>Not user friendly, poor user manual</td>
<td><a href="http://www.suunto.com">www.suunto.com</a></td>
</tr>
</tbody>
</table>

EE = energy expenditure
Our Best Pick for the GPS watch

**Garmin Forerunner 305** – Good energy expenditure, audible alerts for speed, time, and distance, visual interface, usability, heart rate monitor available, easy data transfer.

At each speed (3, 5, and 7 km/hr) Garmin Forerunner 305 consistently underestimates by 50% of mean differences compared to the RT3 accelerometer (a validation tool for the assessment of physical activity). Polar and Suunto tend to underestimate by 35-50% and differences vary in each subject. ADEO overestimates EE by 30-100% but underestimates some by 25%.

The Garmin Forerunner 405, a design based on the 305, was introduced at the time of publication and thus was not tested.

Fun with a GPS Fitness Units

**Geocaching:**

Make your workout twice the fun with an activity, geocaching! This activity combines the use of GPS technology with the outdoor adventure of a treasure hunt. The participants use a GPS receiver (including GPS watches) or other navigational tools to hide and seek containers (called “geocaches” or “caches”) anywhere in the world. Geocache waypoints (or favorite locations) can be found at various websites where the geographic coordinates can be downloaded onto a GPS receiver or watch. Anyone with a GPS unit can then try to locate the geocache. See more information at www.geocaching.com or www.garmin.com/outdoor/geocaching.

**Map@Syst Geocoin:**

One of the fun things about geocaching is discovering what is hidden in the cache! Cooperative Extension is participating through the eXtension Map@Syst Community of Practice, who has developed a special “Geocoin” – an identifiable token (in the shape of a large coin). We have registered hundreds of these coins and are tracking their progress across the U.S. and even to other countries! To learn more about these and how you might integrate them into your GPS physical activity adventures, see http://www.extension.org/pages/Map@Syst_Geocoin_Adventure

References


This information has been reviewed by University faculty.

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