Accelerometer can accurately measure training load in badminton

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05/25/2018
Introduction

• Badminton is a racket sport.

• Actions are short in duration and of high intensity.

• Perform specific movement include: lunging, jumping, powerful strokes.

(Phomsoupha, & Laffaye, 2015)
Internal-Load Monitoring

- The most common method to determine the internal loads of athletes is through Heart Rate (HR) monitoring and analyses.
- Linear relationship between HR and oxygen consumption (VO$_2$).
- Badminton games
  - HR Between 166 and 188 bpm
  - Maximum HR between 191 and 195 bpm

(Cabello-Manrique, 2003; Wonisch, 2003; Coelho, 2012; Abdullahi, 2017)
External-Load Monitoring

- GPS devices
- IMU (accelerometer, magnetometer and gyroscope)
  - monitors and describes movement
  - also provides information on intensity and frequency

(Leser, 2013; Cardinale, 2017)
Accelerometer

- Objective assessment of physical activity (PA)

- Translate the measured acceleration data into relevant information that describes *individual* behavior in terms of physical activity.

  (Sievänen & Kujala, 2017)

- Data for: Physical activity, intensity, time, frequency etc.
Accelerometer

Body Site Locations

- The accelerometer can be attached to different body sites: Hip, wrist, thigh, ankle, chest
  
  (Welk, et al., 2004 & Kamada, et al., 2016)

- **Wrist-worn** location is the ideal site as it is comfortable for the participants

Physical Activity (PA) and Heart Rate

- Heart rate is often used as a **physiological indicator** for athletes in monitoring physical intensity.  
  (Andrew et al., 2013)

- **linear relationship** between speed and HR.

- Speed and heart rate are indicators of energy consumption.  
  (Stallard, et al., 1978; Stallard & Rose, 1980; Reis, et al., 2011)
Heart rate monitoring problems

- HR shows a delayed response to sudden high intensity movements
- Takes some time to return to pre-activity levels
- Heart rate “plateau”
- Factors such as the condition of the court, the temperature, humidity (weather), dehydration and emotional stresses are a few factors that may lead to estimation errors with regard to the internal match load of players

(Jeukendrup, 1998; Coe, 2001)
Advantage of Accelerometer

✓ Real-time exercise intensity
✓ When the heart rate plateaus, the Accelerometer will continue to its measurements

(Cardinale, 2017)
Sensor applications in sports

indoor

outdoor

(Mendes Jr et al., 2016)
Accelerometer & Load Monitoring

- Help to avoid athletics’ injury
- Improve athletics’ performance
- Help to design Training programs and measure athletes/team participation

(Cardinale, 2017)
Purpose

• The purpose of this study is to use the accelerometer to quantify physical intensity.

• provide information for coaches to arrange training programs and improve the performance of the athletes.
Methods

• 5 male participates (3 singles & 2 doubles)

• Level: general, university’s badminton team players

• Age: $21.8 \pm 1.7$ yrs; heights: $173.1 \pm 6.3$ cm; weights: $70.5 \pm 8.4$ kg; training experience: $5.0 \pm 1.8$ yrs

• WisMe physical intensity tracker
Experiment equipment

- Integrate triaxial acceleration

- The Raw data was provide by a cloud system where the top ten intensity values were listed every minute

- Accelerometer was worn on non-dominant wrist
Experiment processing

1. Wore accelerometer on non-dominant wrist
2. Footwork training
3. Specific training situations
   Playing simulation games
Experiment - 1

- Footwork training (six-corners)
  - 20 times x 7 sets

- Compared the intensity between singles and doubles
Experiment - 2

Specific training situations

- Situation one: smash -> net
- Situation two: drop shot -> net
- Situation three: rapid-shots, whole court

Compare intensity of situations
Experiment - 3

- Playing simulation games
  - Singles
  - Doubles

- Compared and listed ratios for the intensity of singles and doubles
Data analysis-1

- Data collection and actual acceleration
- Intensity:
  - Data were collected and analyzed based on the top ten acceleration every minute.
  - AVERAGE (A1:A10)

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Data analysis-2
Relationships between HR, Speed and Accelerometer

![Graph showing the relationship between speed and intensity](image-url)
The data in the simulation was divided into: light, moderate, heavy and maximum rations.
Results & Discussions-1

Footwork training

- Single’s players intensity more higher than double’s players
Results & Discussions - 2

Specific training situations

<table>
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<tr>
<th>smash -&gt; net</th>
<th>drop shot -&gt; net</th>
<th>rapid shot, whole court</th>
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<td>intensity</td>
<td>Heavy (6.5 g)</td>
<td>Moderate (4.7 g)</td>
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</table>

- Different intensities

(smash) > (rapid shot, whole court) > (drop shot)
Results & Discussions - 3

Playing simulation games

**Singles**
- Moderate: 58%
- Light: 18%
- Heavy: 15%
- Maximum: 9%

**Doubles**
- Moderate: 63%
- Light: 9%
- Heavy: 18%
- Maximum: 10%

**INTENSITY LEVEL / TIME**
- Heavy + Maximum = 24%
- Light + Moderate = 76%

**INTENSITY LEVEL / TIME**
- Heavy + Maximum = 28%
- Light + Moderate = 72%
Results & Discussions - 3

- Badminton games characterization
  - Combined 70% aerobic system and 30% anaerobic system.

(Phomsoupha & Laffaye, 2015)
Applications/Practices

- Badminton player’s training-monitoring
- Information for coaches to arrange training programs, design and player’s recovery
- Develop badminton intensity tracking
Research limits

- Participants were general level of male University’s badminton team players.

- Personal physical fitness and skill ability.

- Sensor data used top ten acceleration every minute
Conclusions

- Accelerometer data be used to evaluate badminton intensity.

- Badminton game (Intensity / Time) data results:
  - light to moderate intensity = 70%,
  - heavy to maximum intensity = 30%
Thank you for your attention
Introduction

• Quantified Self
  • incorporate technology into data acquisition on aspects of a person's daily life
• Record physical activity
• Health management
Intensity physical activity

- 129 adults (39 men and 90 women) from York University
- no exercise habits
- Self-Estimate of PA Intensity (walk and/or jog on the treadmill at a speed)
- Peak VO\textsubscript{2} Peak Exercise Test

Subjective assertion will underestimate exercise intensity, objective measurement can give correct exercise intensity

(Canning et al., 2014)