Accelerometer can accurately measure training load in badminton

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Introduction

- Badminton is a racket sport.

- Actions are short in duration and of high intensity.

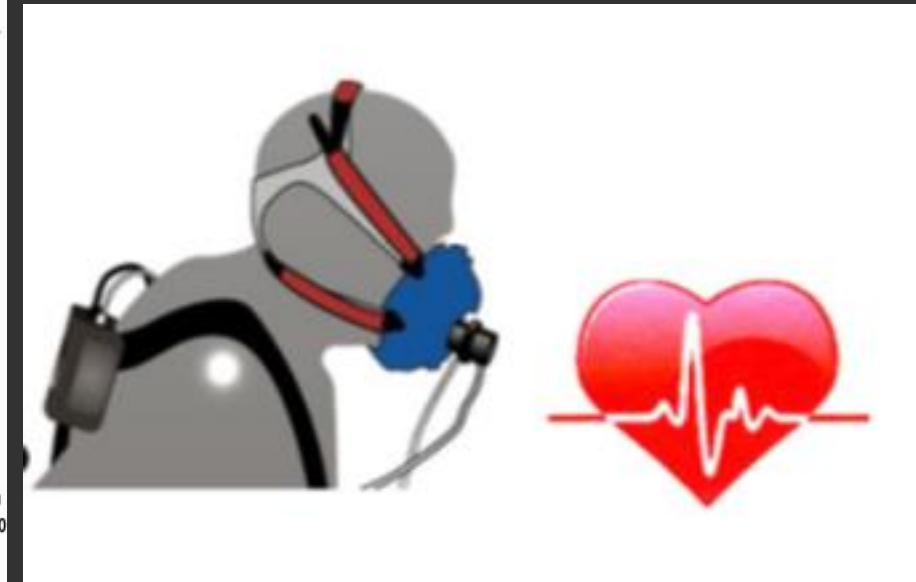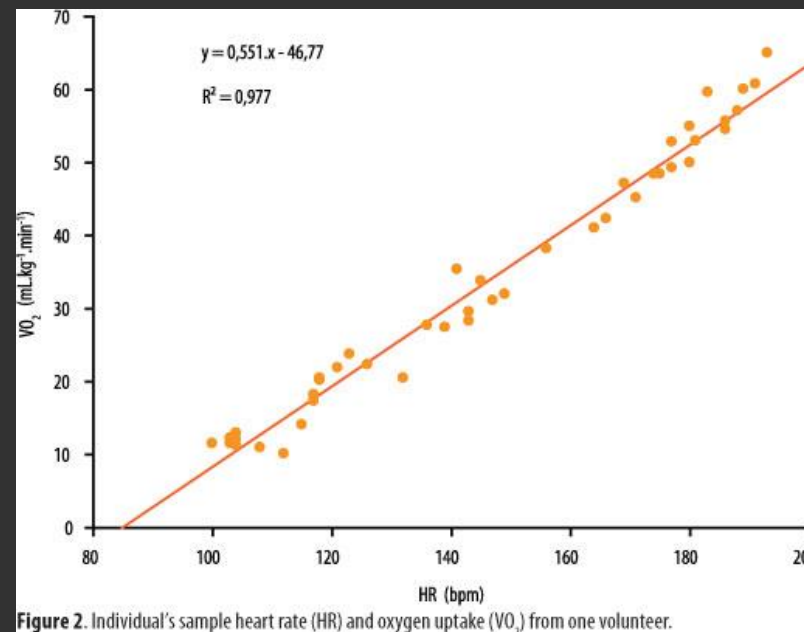- Perform specific movement include: *lunging, jumping, powerful strokes*.

(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$_2$)

$y = 0,551.x - 46,77$

$R^2 = 0,977$

Figure 2. Individual's sample heart rate (HR) and oxygen uptake (VO$_2$) from one volunteer.

- 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

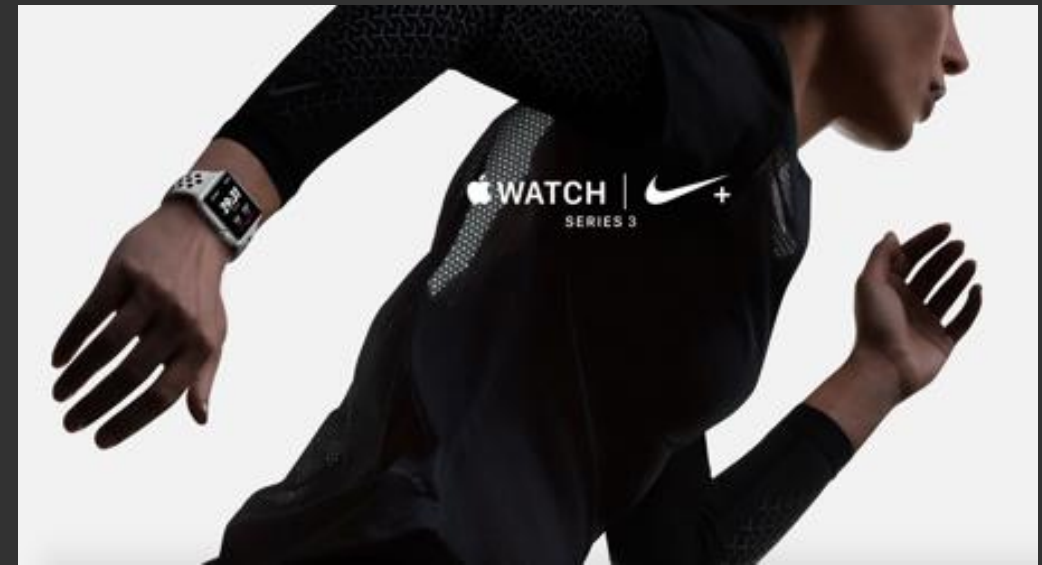   - also provides information on intensity and frequency

（Leser, 2013; Cardinale, 2017）
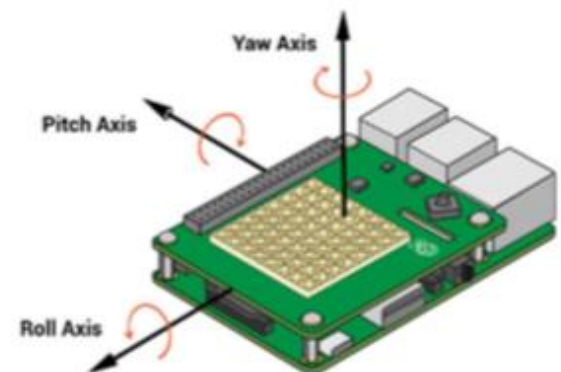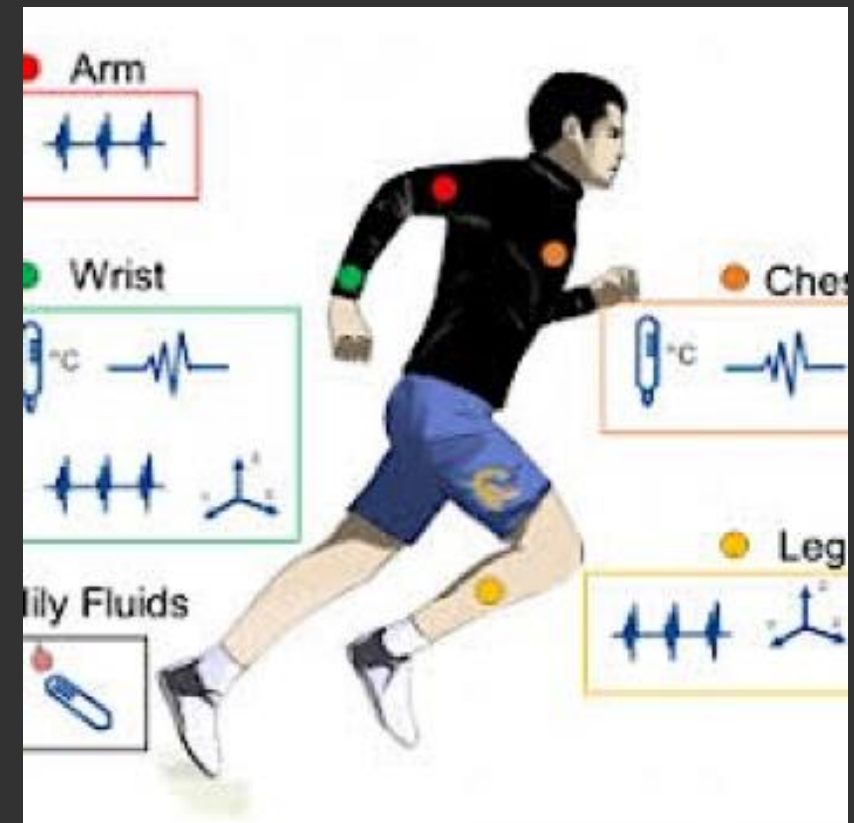

Inertial measurement Units

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

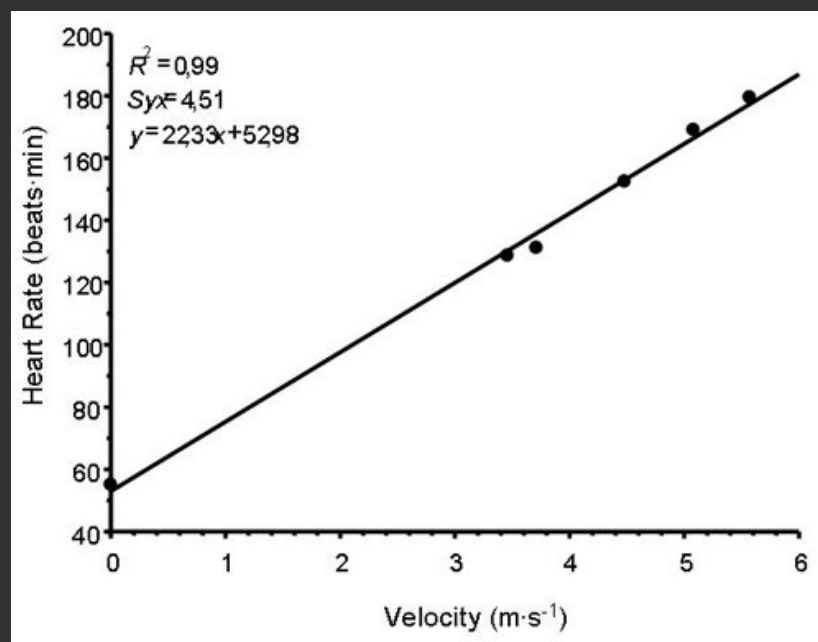(Zhang, et al., 2012, Diaz, et al., 2017)

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
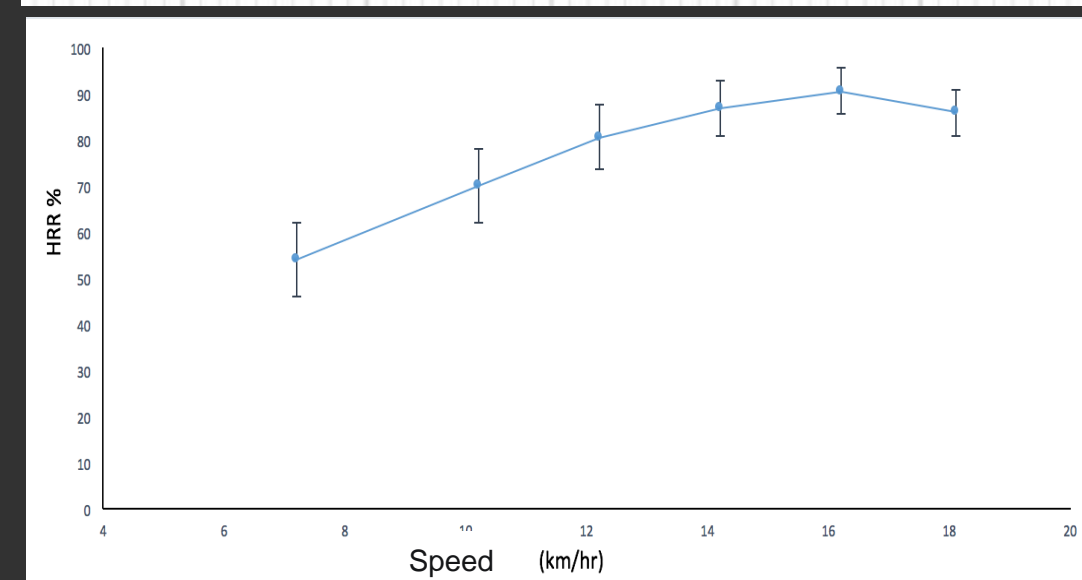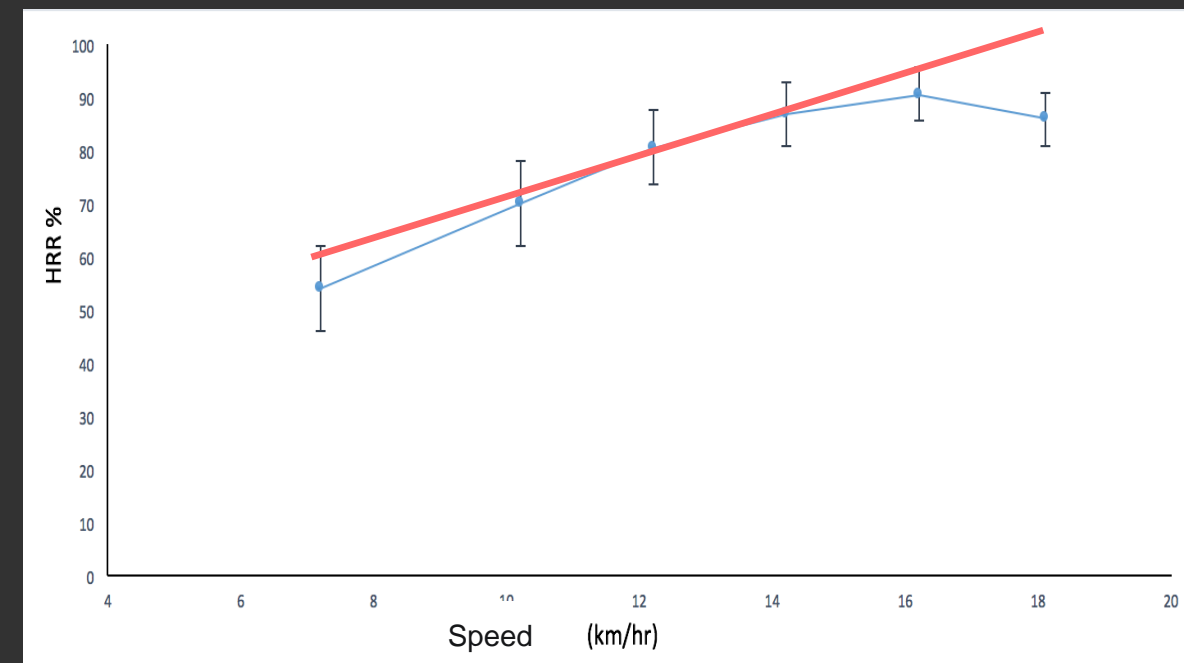
(Jeukendrup, 1998; Coe, 2001)

Advantage of Accelerometer

✓ Real-time exercise intensity

✓ When the heart rate plateaus,

the Accelerometer will continue

to its measurements

(Cardinale, 2017)
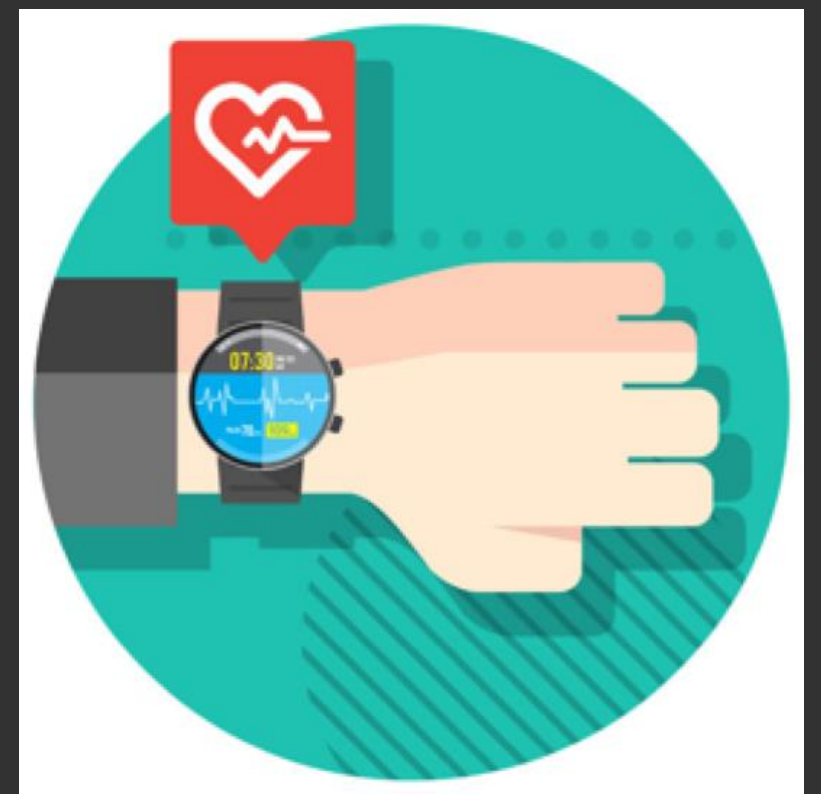
Sensor applications in sports

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 ±1.7 yrs; heights: 173.1 ±6.3 cm; weights: 70.5±8.4 kg; training experience: 5.0 ±1.8 yrs

- WisMe physical intensity tracker
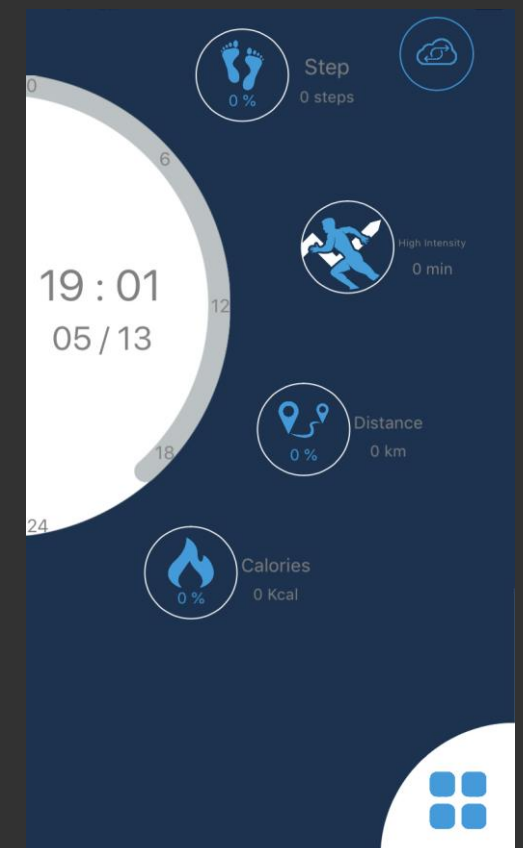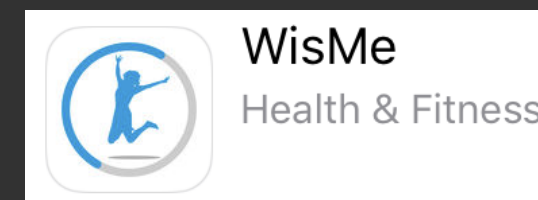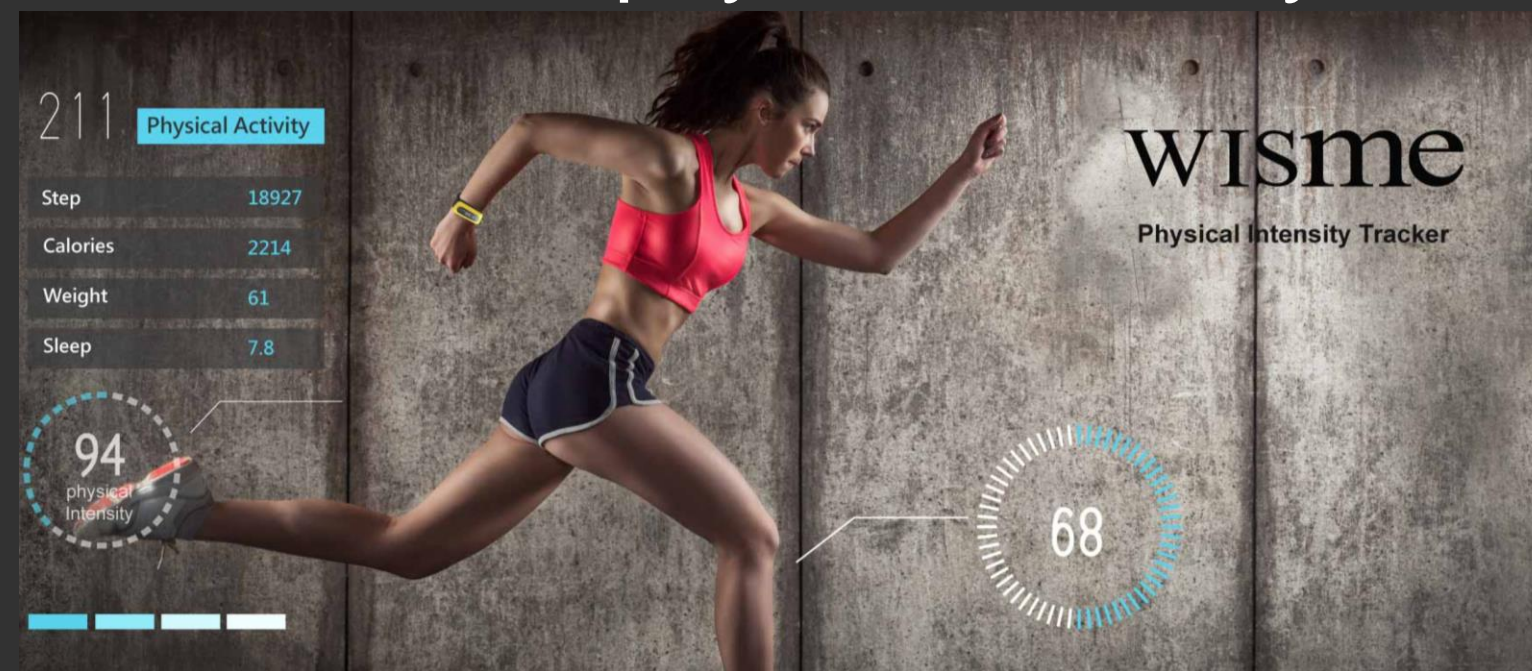
Experiment equipment

y

x

z

- 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
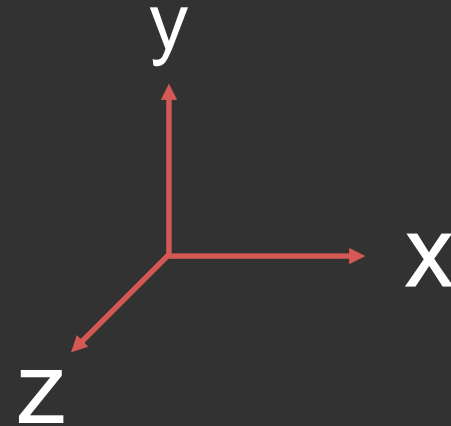
Experiment processing

Wore accelerometer on non-dominant wrist

1 Footwork training

2 Specific training situations

3 Playing simulation games

Experiment - 1

☐ Footwork training (six-corners）

- 20 times x 7 sets

☐ Compared the intensity between singles and doubles
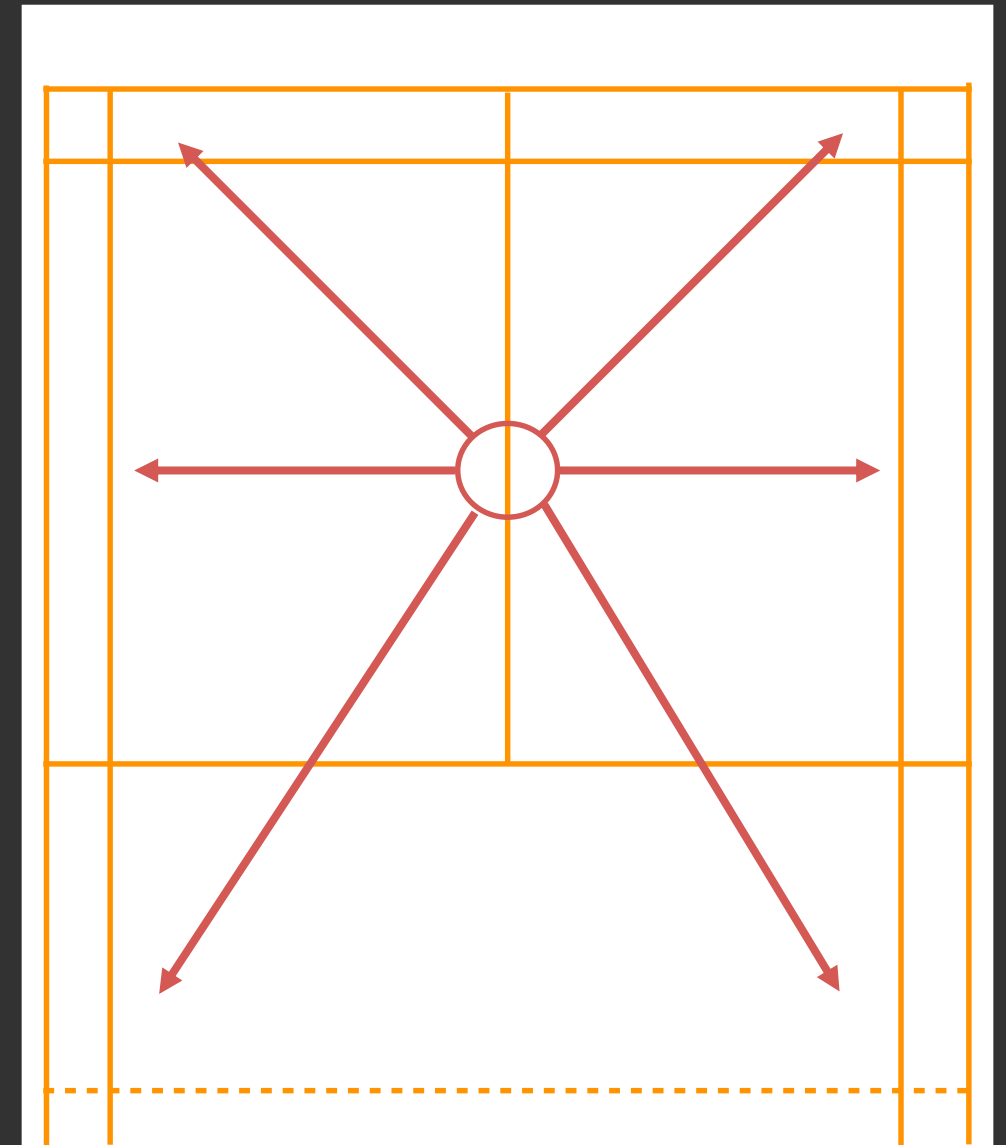
Experiment - 2

☐ 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)

| time	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10
19:36	37	32	32	30	29	27	26	24	24	23
19:37	104	36	34	33	29	29	29	29	28	28
19:38	64	48	43	41	37	37	34	34	34	33
19:39	69	66	61	54	48	47	45	37	37	35
19:40	52	39	39	38	36	30	28	28	26	23
19:41	98	97	95	89	87	86	85	84	81	80
19:42	110	107	103	101	101	100	99	95	92	89
19:43	118	107	104	104	98	97	95	93	93	92
19:44	111	108	105	102	98	95	92	92	90	90
19:45	116	115	115	113	101	101	98	94	94	92
19:46	100	99	91	85	84	84	83	82	81	80
19:47	134	127	114	106	98	93	90	85	84	78
19:48	123	101	101	98	97	95	93	88	86	86
19:49	122	119	116	101	97	89	88	86	83	83
19:50	134	121	113	94	94	94	94	87	84	82
19:51	124	119	115	112	100	87	84	79	77	72

Data analysis-2
Relationships between HR, Speed and Accelerometer
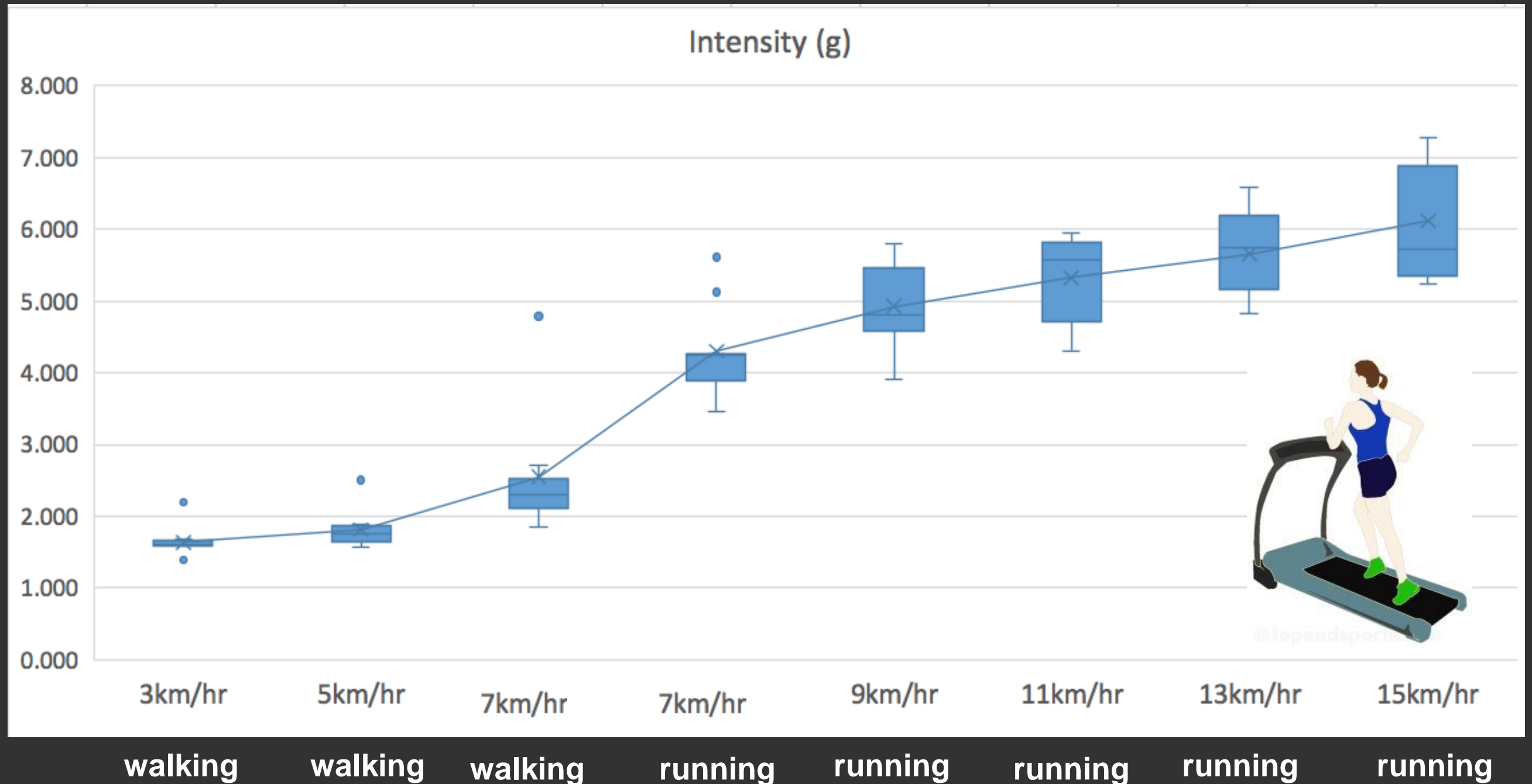
Data analysis-2 intensity zone
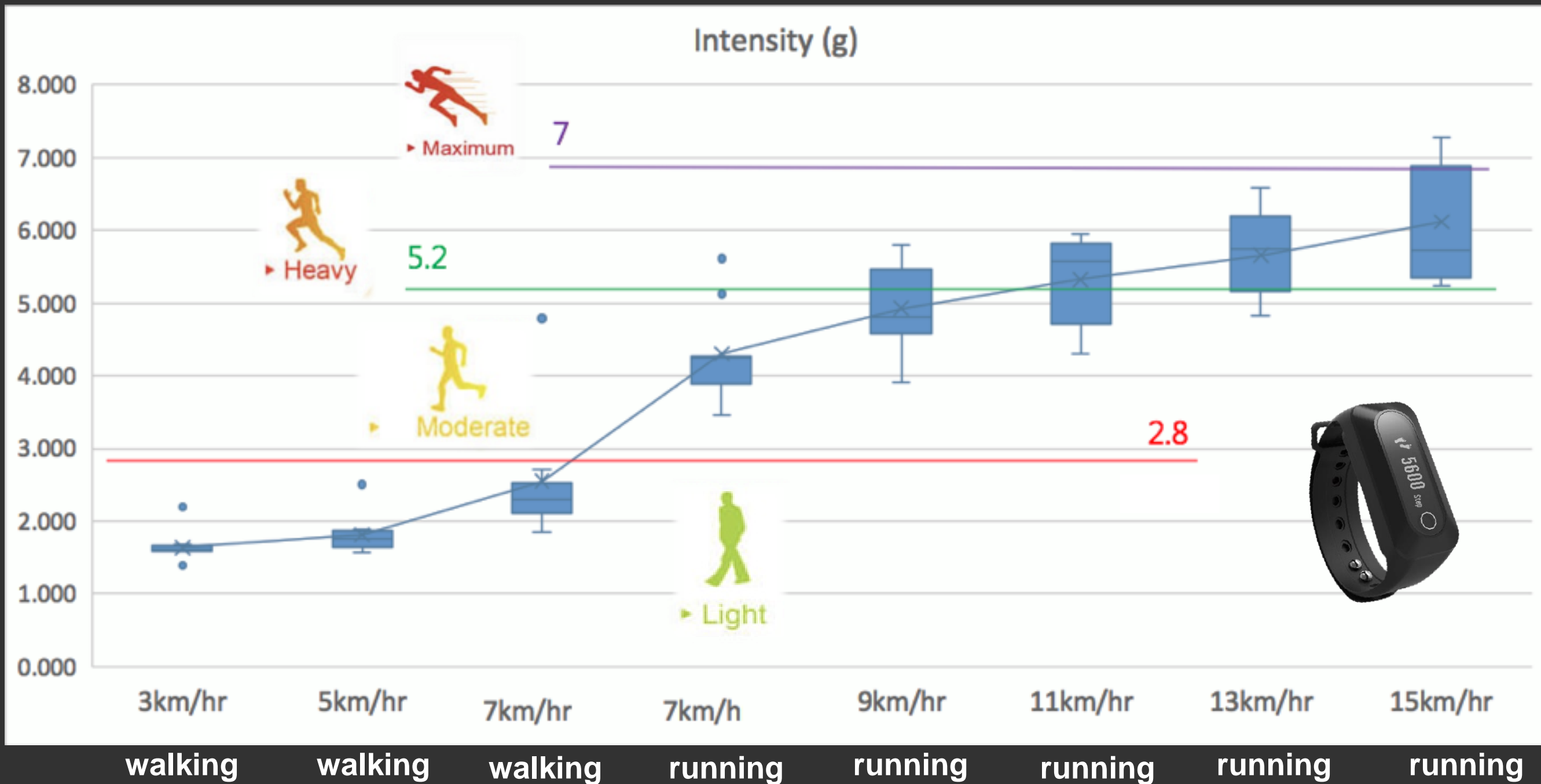
- The data in the simulation was divided into: light, moderate, heavy and maximum rations

Results & Discussions-1
Footwork training

Intensity (g)

	singles A	singles B	singles C	doubles A	doubles B
value	5.0	6.0	4.2	3.6	3.7

	intensity
singles	Moderate (5.1 g)
doubles	Moderate (3.7 g)

- Single's players intensity more higher than double's players

Results & Discussions-2

Specific training situations

intensity	smash -> net	drop shot -> net	rapid shot, whole court
	Heavy（6.5 g）	Moderate（4.7 g）	Heavy（6.3 g）

- Different intensities

(smash) > (rapid shot, whole court) > (drop shot)

Results & Discussions - 3
Playing simulation games

Singles

Maximum 9%
Light 18%
Heavy 15%
Moderate 58%

Doubles

Maximum 10%
Light 9%
Heavy 18%
Moderate 63%
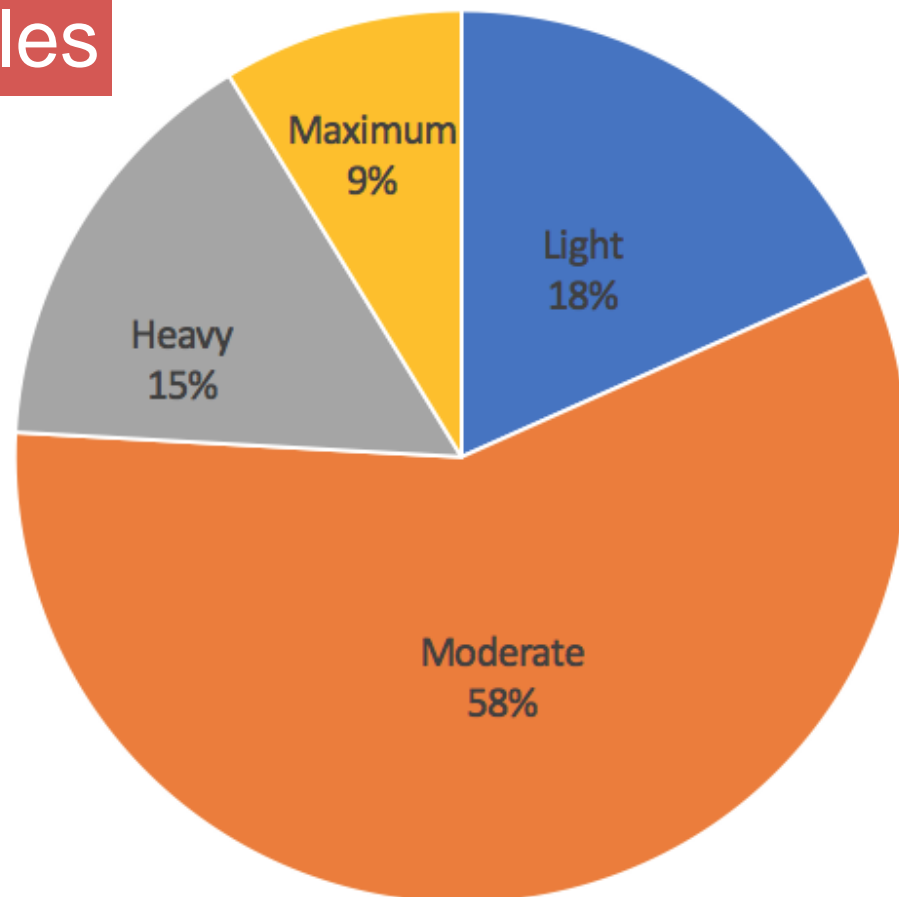
INTENSITY LEVEL / TIME
Heavy＋Maximum＝24%
Llight＋Moderate＝76%
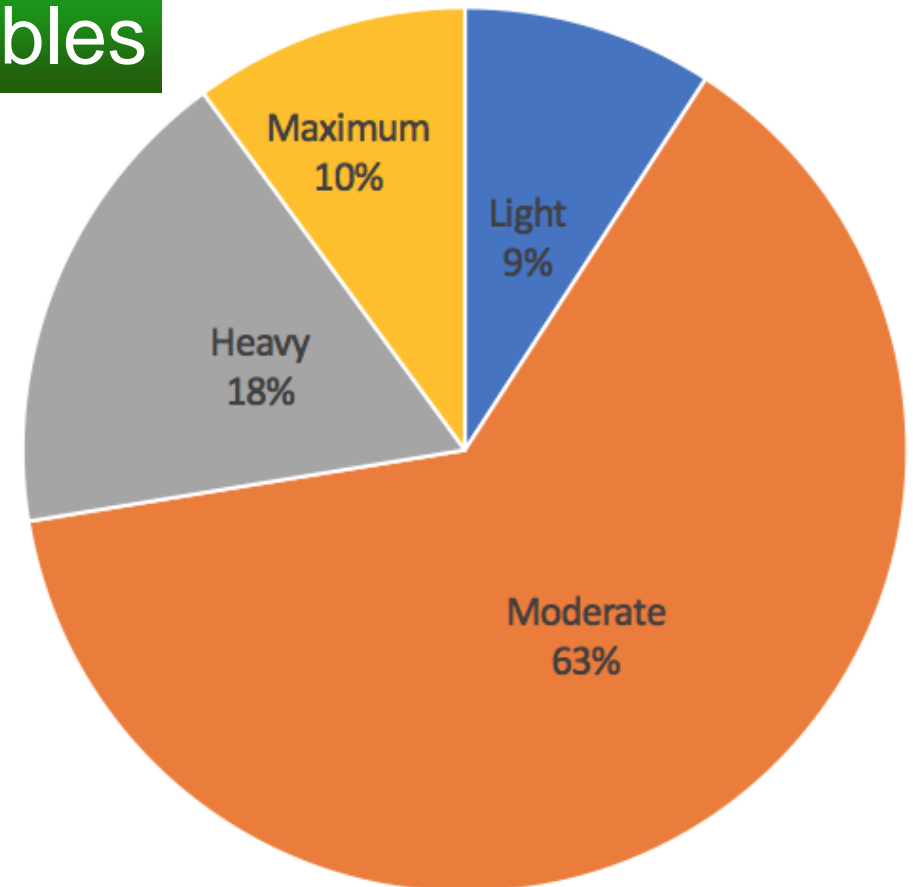
INTENSITY LEVEL / TIME
Heavy＋Maximum＝28%
Llight＋Moderate＝72%

Results & Discussions - 3

- Badminton games

  characterization

  - Combined 70% aerobic

    system and 30% anaerobic
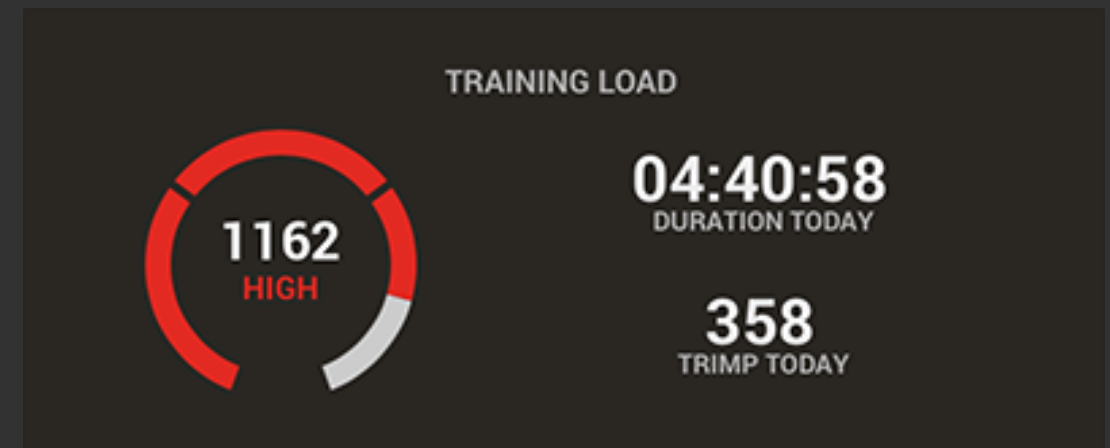
    system.

30%
anaerobic

70%
aerobic
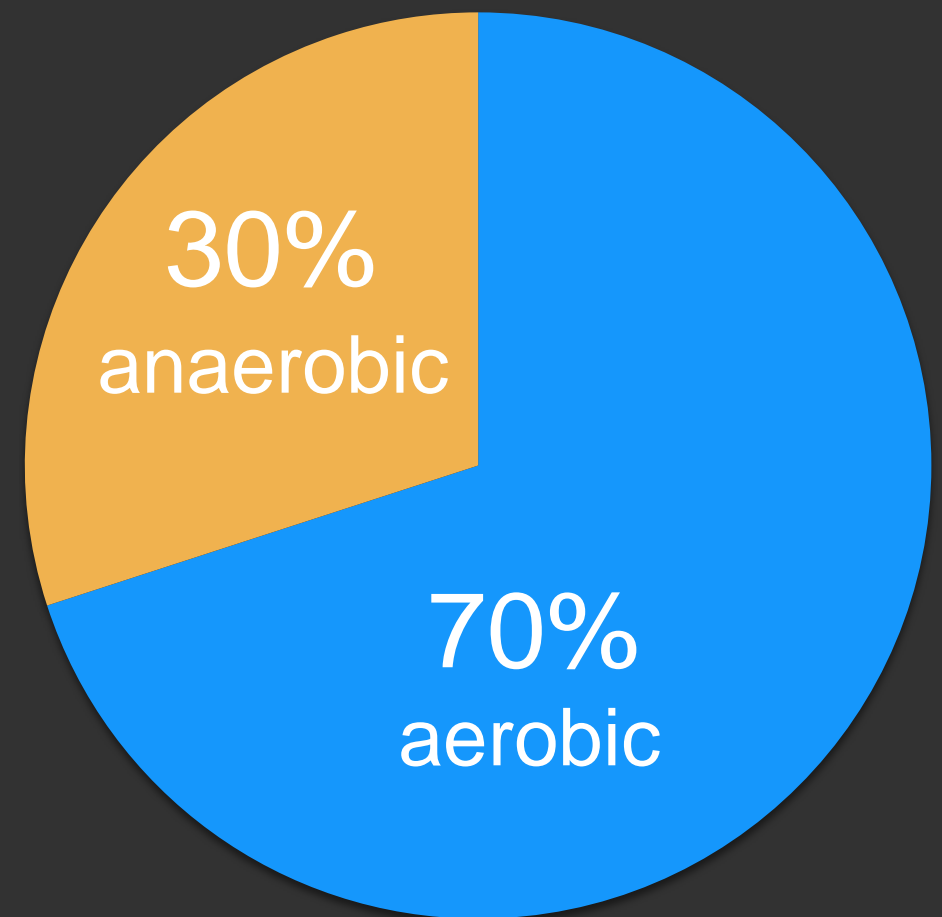
(Phomsoupha & Laffaye, 2015)

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

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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$_2$Peak Exercise Test

(Canning et al., 2014)

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