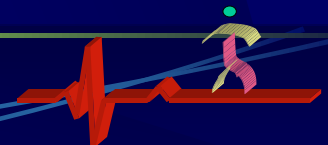


# Measurement of Energy Expenditure, Physical Activity and Sedentary Behaviors

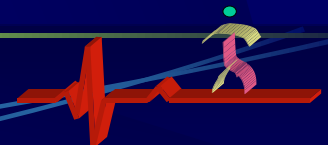
**Hazzaa M. Al-Hazzaa, PhD, FACSM, FECSS**

Professor & Head, Lifestyle & Health Research,  
Health Science Research Center,  
Princess Nourah University

October/8/2018



**20 slides are shown  
of 86 slides**



# Major Outlines

## Part I:

- Basic concepts in physical activity science.

## Part II:

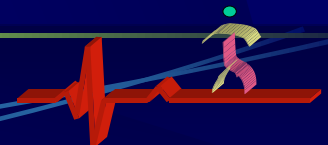
- Overall descriptions of methods used in measurement of energy expenditure and physical activity in human.

## Part III:

- Measurement of energy expenditure by direct and indirect calorimetry as well as by doubly labeled water.

## Part IV:

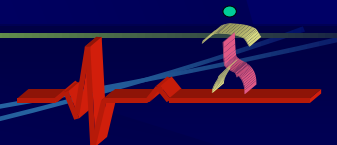
- Assessment of PA & SB using various methods (PA monitors, HR telemetry, direct observation, questionnaires).



# Domains of Physical Activity

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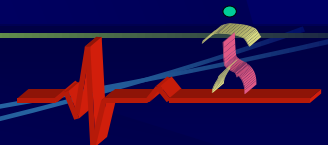
- ❖ Leisure-time physical activity (fitness & sports activities)
- ❖ Household/gardening physical activity
- ❖ Occupational physical activity
- ❖ Active transport



# **Physical Activity is Important for Health**

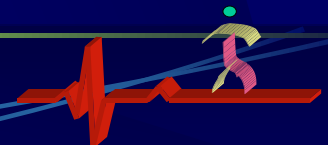
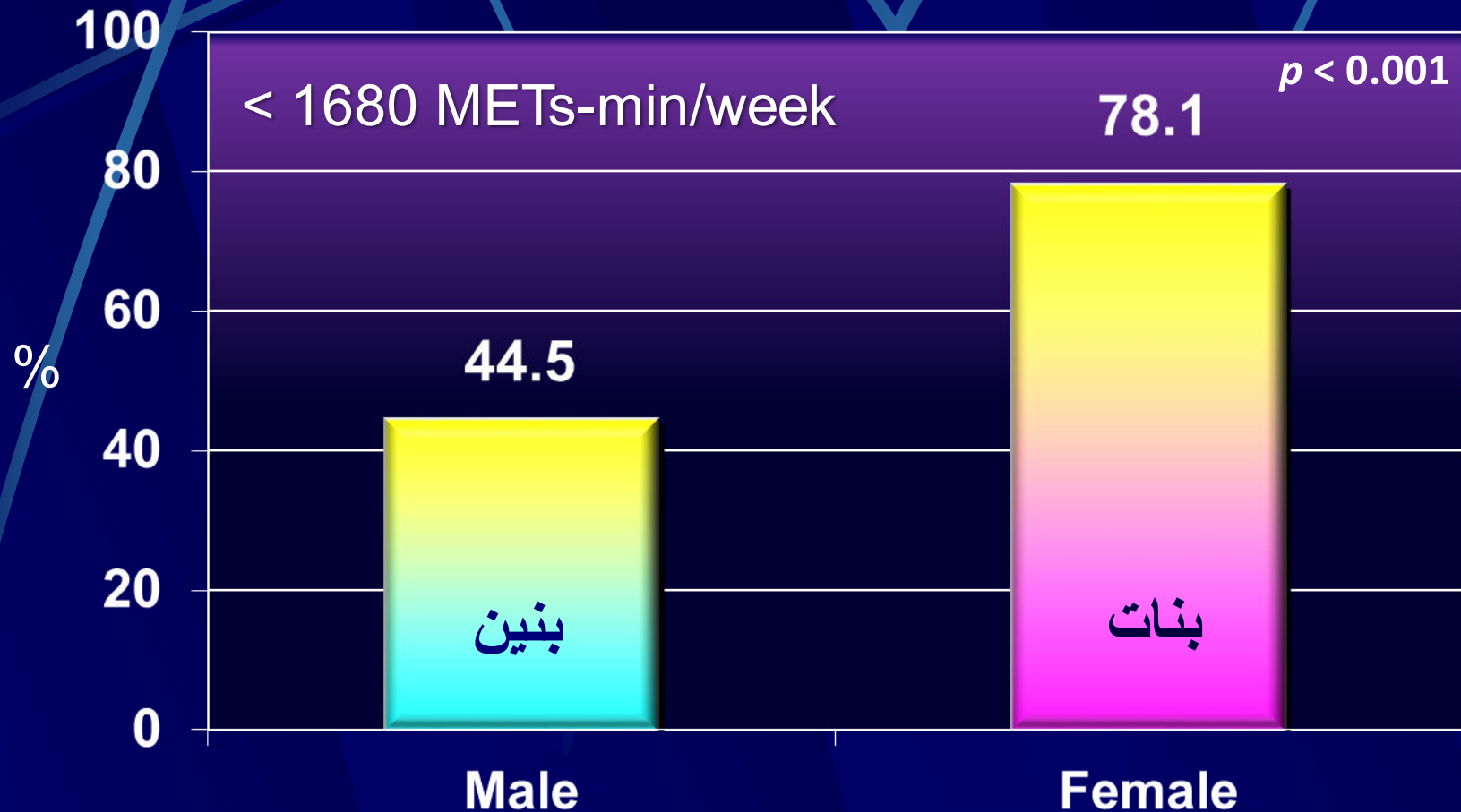
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**Our ability to correlate physical  
activity or energy expenditure  
with Health markers depends  
on valid and reliable  
measurement**



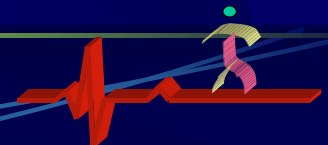
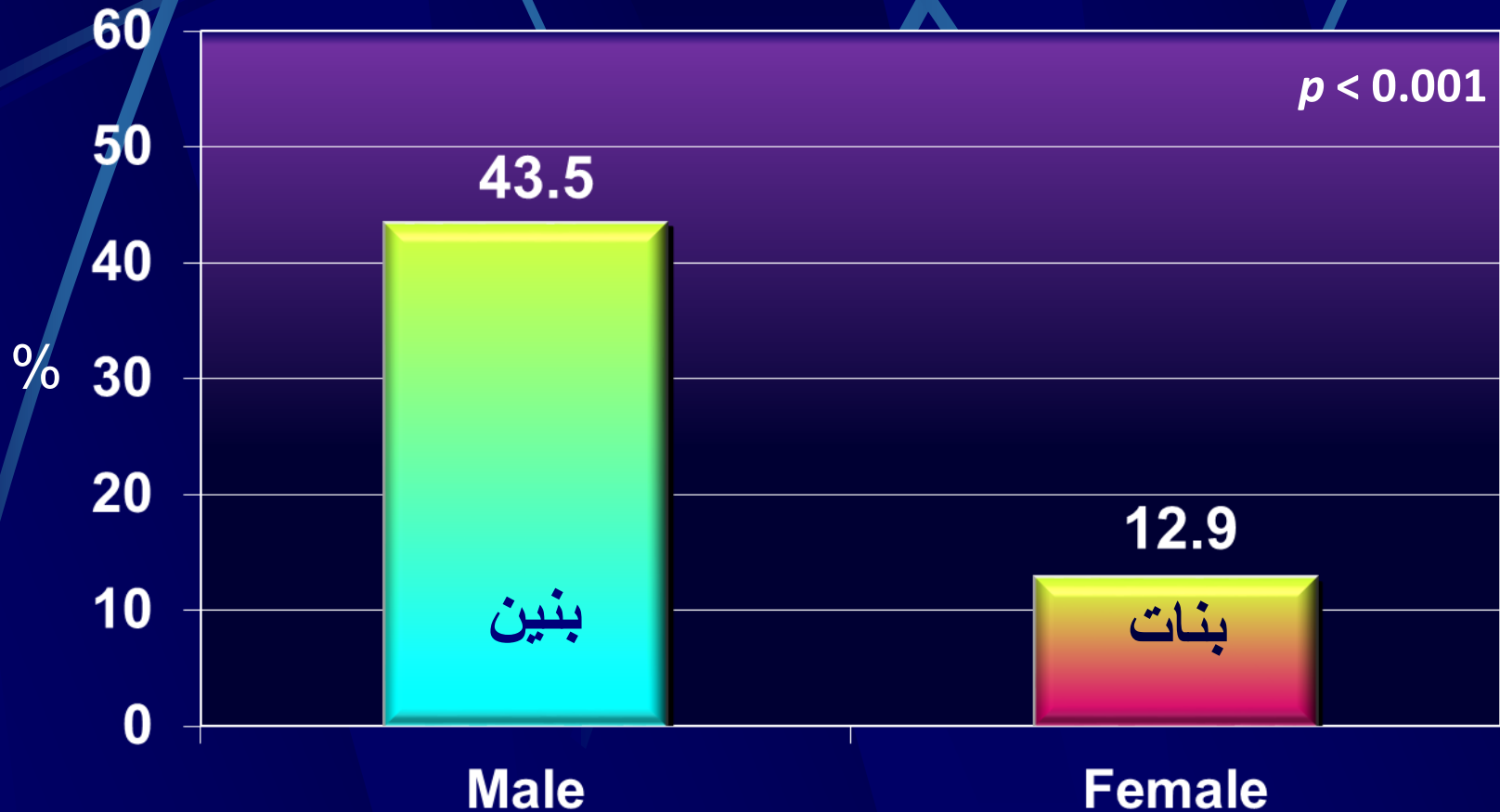
# Prevalence of Physical Inactivity among Saudi Adolescents (ATLS Questionnaire)

14-19 year-olds, N= 2906



# Proportion of Saudi Adolescents engaging in Vigorous ( $\geq 6$ METs) Physical Activity

14-19 year-olds, N= 2906



# Methods of Assessing Energy Expenditure & PA

الاستبانة (Questionnaire)

سجل رصد النشاط البدني (Activity Diaries)

قياس الحركة بواسطة عداد المسافة (Pedometer)

قياس الحركة بواسطة مقياس الحركة (Motion Sensor)

رصد ضربات القلب (Heart Rate Monitoring)

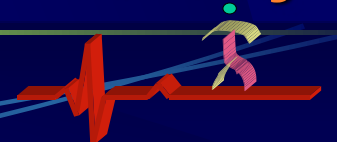
المراقبة المباشرة (Direct Observation)

استخدام الماء غير المشع (Doubly labeled Water)

قياس استهلاك الأوكسجين (Oxygen Consumption)

**Simplicity**

**Validity**

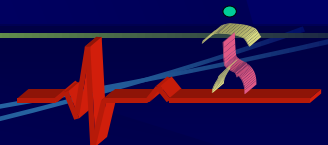




## Objective Physical activity Measures- Pitfalls-2

- ❖ There may be a reactive response to wearing of the instrument (reactivity behaviors) and this effect can disappear with longer wearing periods.
- ❖ Accelerometers usually average activity counts over epochs that range from 1 to 60 seconds, and choosing too long an epoch misses or underestimates some movements, especially in children, where short bursts of activity are common.
- ❖ Further, when the participants wearing the pedometer could see the reading count, this may increase the number of steps (**11,385** steps/day) compared to those with sealed pedometers (**9541** steps/day).

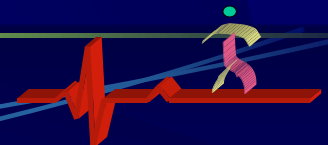
*Clemes SA, et al. Br J Sports Med. 2008; 42: 68–70*



# Assessing Physical Activity by Questionnaires

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- **Low cost.**
- **Easy to administer (more efficient in large sample).**
- **Can assess context (where, why & type).**
- **Can assess history.**
- **Low burden to participant.**
- **Most practical with large survey involving other Health markers.**



# Measurement of energy expenditure in human

## Calorimetry

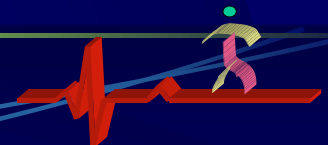
```
graph TD; A[Calorimetry] --> B[Direct Calorimetry]; A --> C[Indirect Calorimetry]; B --> D[Measurement of Heat production]; C --> E[Measurement of O2 & CO2 Outputs];
```

### Direct Calorimetry

Measurement of Heat production

### Indirect Calorimetry

Measurement of O<sub>2</sub> & CO<sub>2</sub> Outputs



# Indirect Calorimetry (Fuel type)

**Respiratory Quotient** = CO<sub>2</sub> production/O<sub>2</sub> uptake

\*\*\* Steady state \*\*\* otherwise it is called RER

RQ-Carbohydrates = 1.0

RQ-Proteins = 0.8

RQ-Fats = 0.7

RQ-Mixed diet = 0.85

Glucose

$$\text{CHO} = 6/6 = 1$$

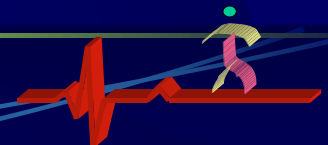


Palmitic Acid

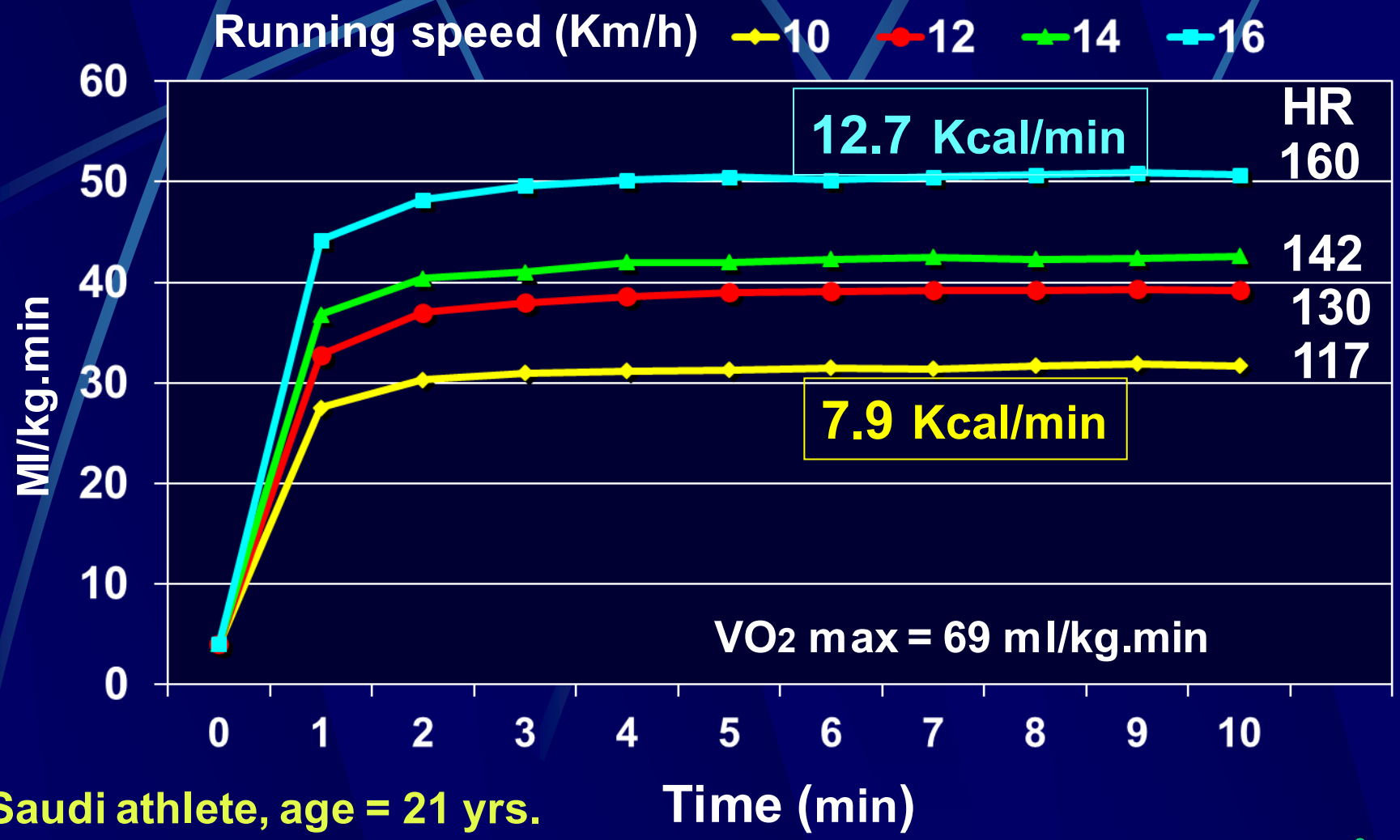
$$\text{Fat} = 16/23 = 0.7$$



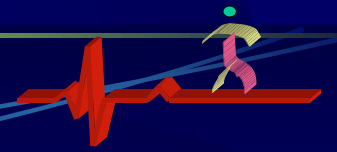
RER = Respiratory Exchange Ratio



# Oxygen uptake & energy expenditure during exercise



Data from: Al-Hazzaa, 1993



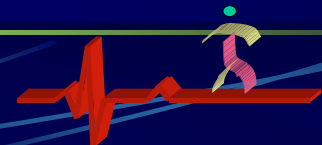
# Doubly Labeled Water (DLW) Method -2

## Advantage

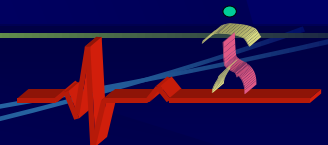
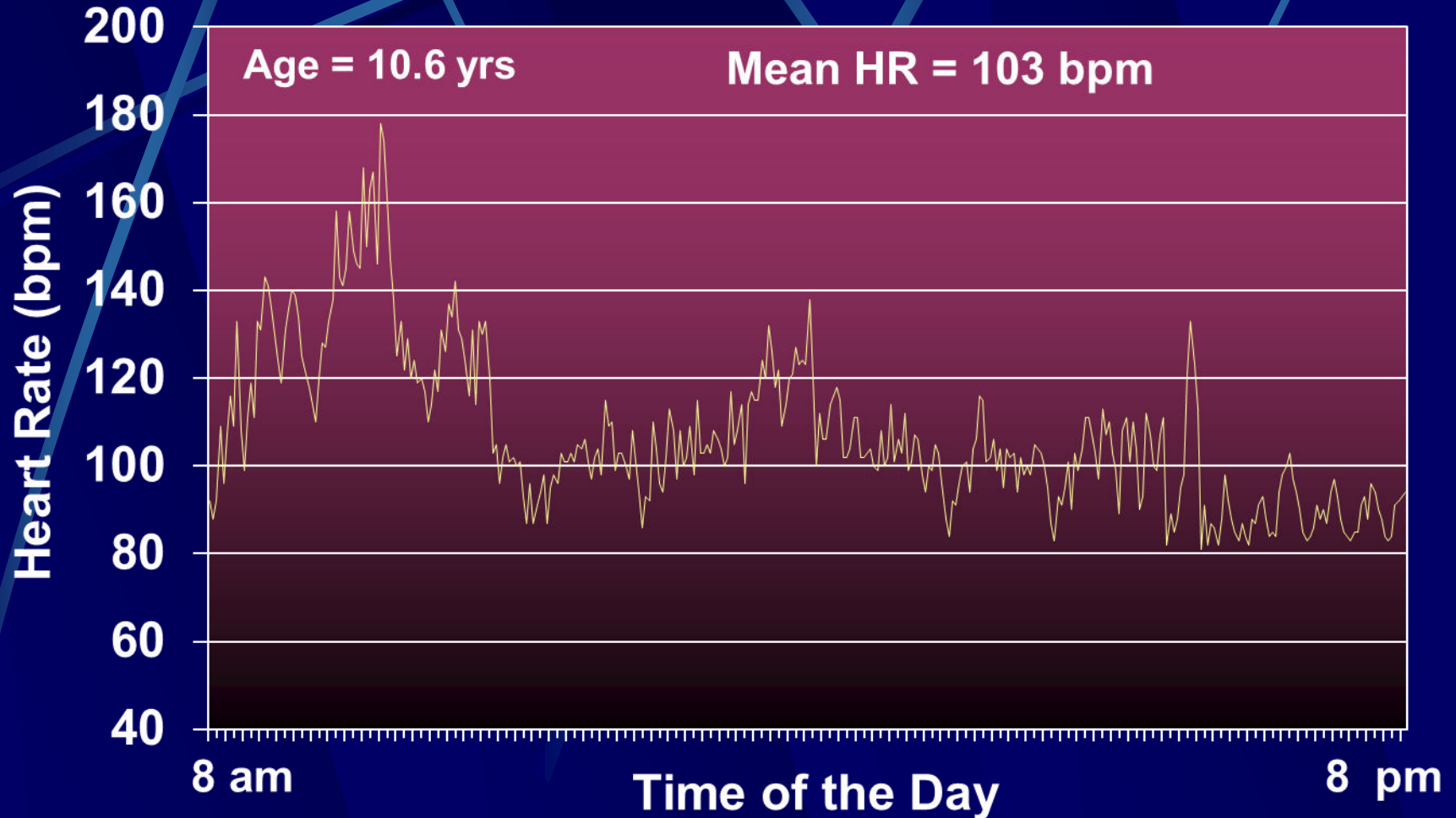
- No requirement for subject compliance.
- The method can be used to validate other techniques.

## DLW Drawbacks

- Cost of  $^{18}\text{O}$  labeled water is high.
- Requires an expensive isotope ratio mass spectrometer.
- Needs extensive sample preparation system.

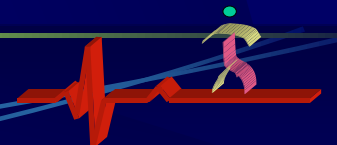


# Continuous Heart Rate Telemetry for a Saudi Boy



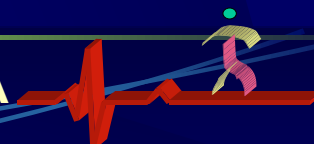
# Activity Monitors

أجهزة قياس الحركة



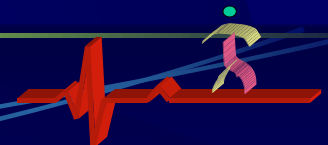
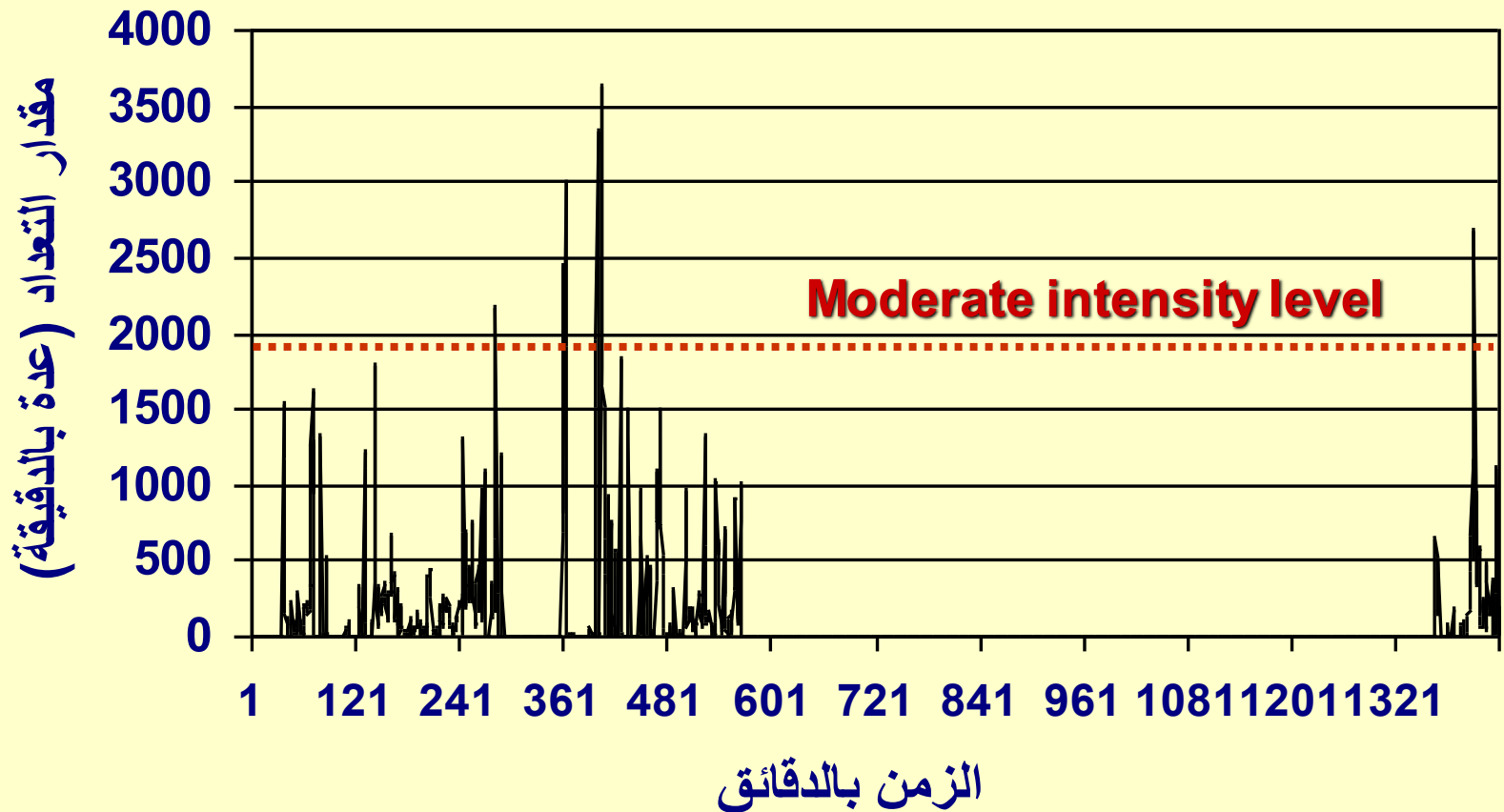


# Variety of Activity Monitors



# Continuous monitoring by accelerometer for an inactive adolescent

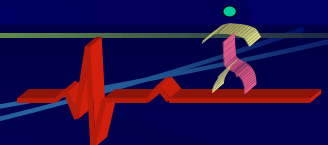
Counts/min



# Assessing Physical Activity with GPS (2)

## ❖ Cons

- ❖ Data requires smoothing (algorithms to identify behaviors are complex & not available to everyone).
- ❖ Geographic information system (GIS) expertise is required to map locations & match resources.
- ❖ GIS may not match resolution of GPS data.



# Assessment of Sedentary Behaviors

قياس السلوك الخامل  
(مدة الجلوس)

