UNIVERSITY OF PÉCS
MEDICAL SCHOOL

SPORTMED
PTE ÁOK SPORTMEDICINA TANSZÉK

# Monitoring sports performance

## Practice-oriented sport medicine

Eva Tékus (PhD)

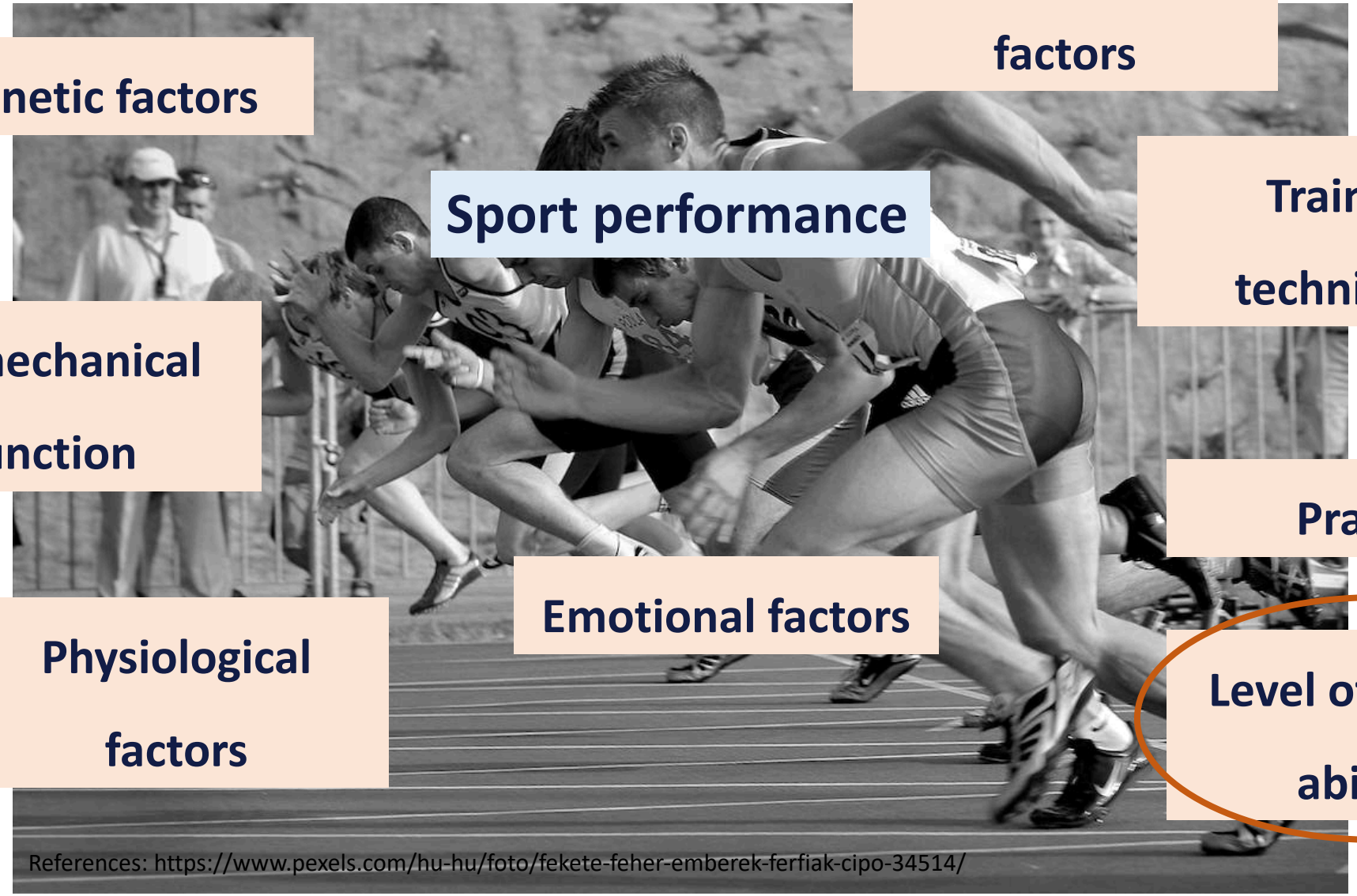
POTEcho

**PTE902**

http://potecho.pte.hu

spring semester 2026, Pécs

# Sport performance




References: https://www.pexels.com/hu-hu/foto/fekete-feher-emberek-ferfiak-cipo-34514/

# Physical performance - Classification of physical abilities

## Conditional physical abilities:

1. Endurance
2. Force (strength)
3. Speed

**Flexibility**

## Coordinational physical abilities:

1. Ability to differentiate (coordination)
2. Coupling or synchronization capacity
3. Rhythm ability or rhythm
4. Balancing ability
5. Readaptation or change capacity
6. Guidance capacity
7. Reaction capacity

**Special abilities**

References: http://tamop-sport.ttk.pte.hu/files/tananyagfejlesztes/motorikus-kepessegek-merese.pdf
https://www.lifepersona.com/what-are-conditional-physical-capabilities-classification
https://www.lifepersona.com/what-are-coordinating-physical-capabilities

# Other aspects of the sport performance
# Fitness definition and types

Howley & Franks (2007) as "a state of well-being with a low risk of premature health problems and energy to participate in a variety of physical activities."

Types:
- Skill-related fitness (agility, balance, coordination, speed, power)
- Health-related fitness

Healthy person< Trained (fit) person< Competitive athletes

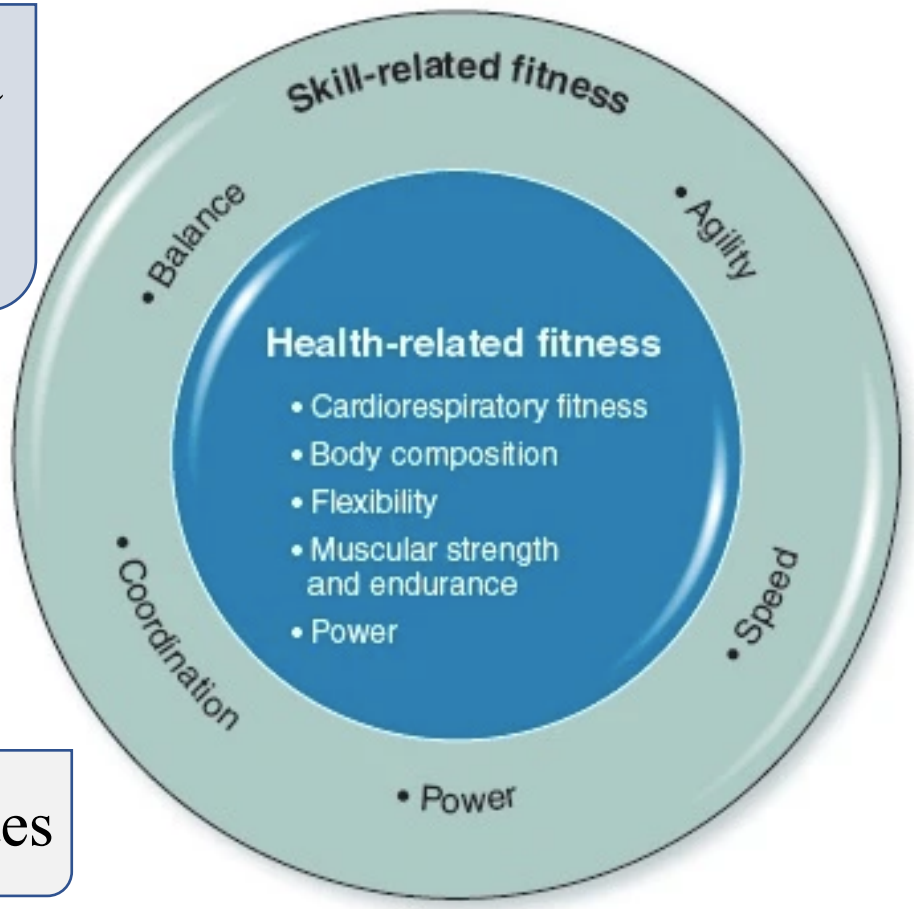



FIGURE 14.1 Components of physical fitness.



Reference: https://canada.humankinetics.com/blogs/physical-education-and-health/health-related-fitness-skill-related-fitness-manipulative-skills

# The most frequently measured components of physical performance

**Components of physical performance (or health related physical fitness):**

1. muscular endurance
2. cardiovascular endurance
3. muscular strength /force
4. body composition
5. flexibility

**Need for measurements:**

- Aim / aims of the measurement
- Participants (age, gender, sport habits, health status)
- Available devices, infrastructure and professionals

# Measurement of physical performance (Premier League fitness test)

**https://www.youtube.com/watch?v=4FtmxYFhnT4**

| Physical abilities | Name of the test |
|---|---|
| Speed | |
| Strength endurance (static) | |
| Endurance (field test) | |
| Agility, speed | |
| Strength endurance (dinamic) | |
| Strength of lower limb/ explosive strength | |
| Endurance (laboratory test) | |

# Measurement of physical performance (Premier League fitness test)

| Physical abilities | Name of the test |
|---|---|
| Speed | 10, 20, 30 m sprint |
| Strength endurance (static) | Plank test |
| Endurance (field test) | Beep test (20 m shuttle run test) |
| Agility, speed | 5-0-5 agility test |
| Strength endurance (dinamic) | Max push up test |
| Strength of lower limb/ explosive strength | Vertical jump test |
| Endurance (laboratory test) | $VO_2$max test |

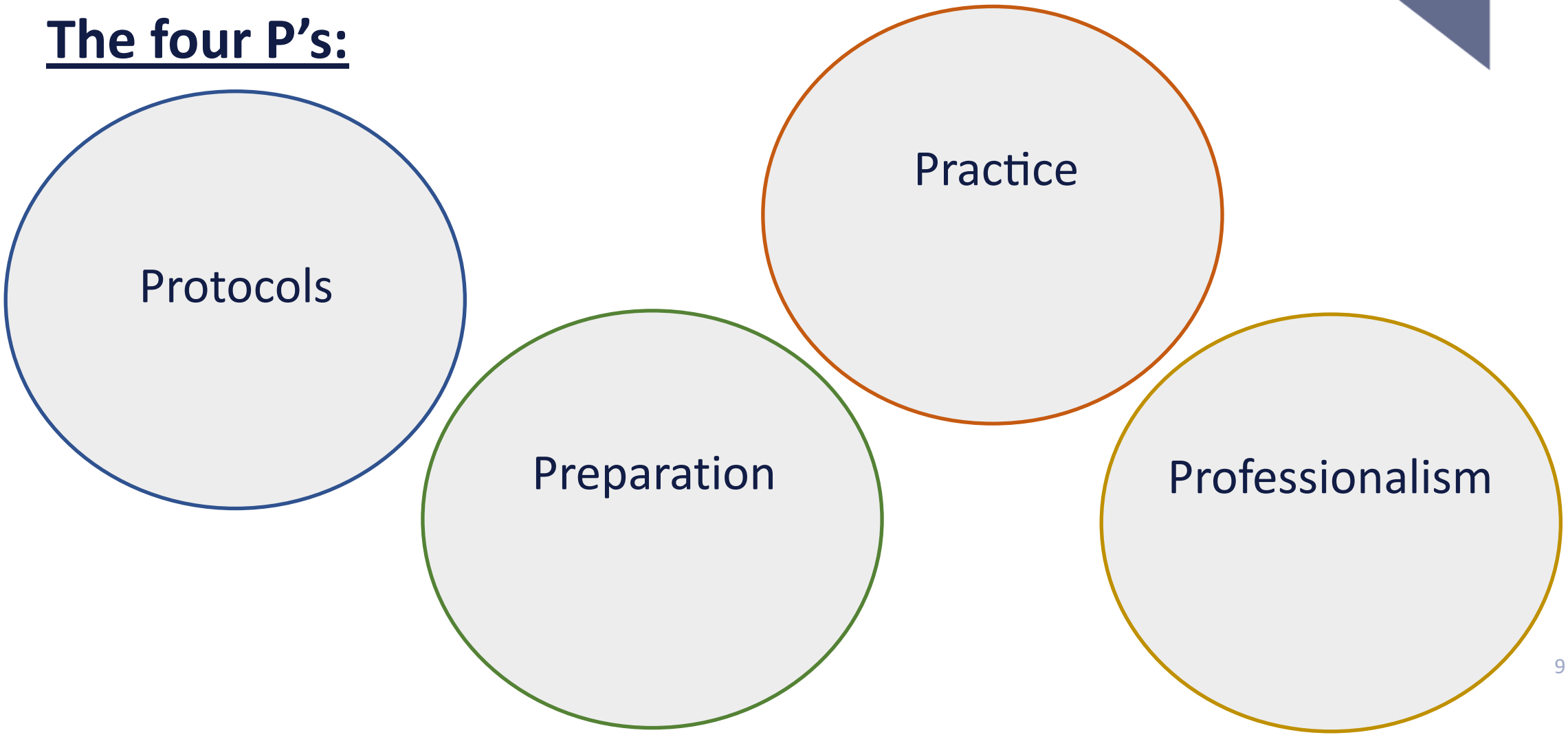
# Purposes of physical performance measurements

1. Measurement of actual physical performance:
    - Screening athletes with physical tests (professional athletes: after sport injury and rehabilitation, end of summer holiday, or patients before change in lifestyle etc.)
    - Measurements for sport science researches

2. Regular physical performance measurement and follow-up:
    - For creating an individual training plan
    - For measuring the effectiveness of the training
    - Measurements for sport science researches

# Principles of physical performance measurement

## The four P's:



# Steps of physical performance measurement

1. Create protocol, ethical permission
2. Participants (recruit, informed consent)
3. Anamnesis, collection of training and sociodemographic data
4. Sport anthropometric measurements
5. Measuring actual physical abilities (according to standardized protocols)
6. Evaluation of measured results

**Hungarian National Institute of Sports Health**
**Athlete Post-COVID protocol of Movement laboratory**

Introduction of this protocol
„Complications of Covid-19 include factors that reduce general fitness and endurance. Involvement of the cardiovascular and respiratory systems may significantly limit the possibility of returning to sport. If the examination of symptoms does not confirm organ involvement, it is recommended that the examination be extended to include strength and endurance tests and exercise physiology tests.”



Reference: https://www.osei.hu/dokumentumok/2022/Mozg%C3%A1slabor%202022.pdf

# Athlete Post-COVID Protocol

**Applied methods:**

1. Anamnesis
2. Diagnostic assessment
   - 2.1. Recording of basic physical and vital parameters (blood pressure, $O_2$ saturation, heart rate, respiratory rate)
   - 2.2. Spirometry test
   - 2.3. Harvard step test
   - 2.4. Bruce treadmill protocol
   - 2.5. Measurement of muscle strength using the HumacNorm measuring device
   - 2.6. Spiroergometry test
3. Rehabilitation



Reference: https://www.osei.hu/dokumentumok/2022/Mozg%C3%A1slabor%202022.pdf

# Endurance

Endurance: ability to maintain muscle movement for an extended amount of time

Cardiovascular endurance: ability to deliver oxygen to working muscles, where it can be used to produced energy. $VO_{2max}$ is a good marker.

Muscular endurance: ability to maintain contracting a muscle, against resistance for an extended period of time.

Types:

- Aerobic endurance
- Anaerobic endurance

- Strength endurance
- Speed endurance etc.

References: http://tamop-sport.ttk.pte.hu/files/tananyagfejlesztes/motorikus-kepessegek-merese.pdf
http://www.jgypk.hu/tamop13e/tananyag_html/tananyag_motoros/v3_az_llkpessg.html

# Measuring of endurance

- Field tests E.g. Cooper test, 20-meter shuttle run test
https://www.youtube.com/watch?v=Ko1qHVN7DXo

- Laboratory test E.g. spiroergometric test – like Bruce protocol

https://www.youtube.com/watch?v=g3msO9bLODg

References: http://tamop-sport.ttk.pte.hu/files/tananyagfejlesztes/motorikus-kepessegek-merese.pdf
Cooper C.B, Storer T.W. Exercise testing and interpretation. A practical approach. Cambrige University Press, Cambrige, 2004

# Measuring Endurance – Harvard Step Test, Queens College Step Test

**Harvard Step Test (Brouha et al, 1943)**

- 5 min long, step on measuring bench (50 cm), 30 steps/min
- Heart rate measurement: between 1 and 1.5 mins, 2 and 2.5 mins; 3 and 3.5 mins)
- **Fitness Index (FI) calculation**:

FI= 100 x test duration / (2 x sum of three heart rates)

**Queens College Step Test (McArdle et al, 1972)**

- 3 min, 41.7 cm surface, 22 steps/min
- Heart rate (HR) measurement immediately after the step test.
- **Formula for men**:

$VO_2max$= 111.33 – (0.42 x HR)

- **Formula for women**:

$VO_2max$ = 65.81 – (0.1847 x HR)

22 bpm metronome: https://www.youtube.com/watch?v=YBPeu6Xbx3s

Refernces: http://tamop-sport.ttk.pte.hu/files/tananyagfejlesztes/motorikus-kepessegek-merese.pdf
Cooper C.B, Storer T.W. Exercise testing and interpretation. A practical approach. Cambrige University Press, Cambrige, 2004

# Relative $VO_2$max categories for healthy adults (AHA, 1972; expressed in ml/kg/min)

| Age / Gender | Low | Weak | Average | Good | Excellent |
|---|---|---|---|---|---|
| 20-29 years | | | | | |
| Male | ≤ 24 | 25 - 33 | 34 - 42 | 43 - 52 | ≥ 53 |
| Female | ≤ 23 | 24 - 30 | 31 - 37 | 38 - 48 | ≥ 49 |
| 30-39 years | | | | | |
| Male | ≤ 22 | 23 - 30 | 31 - 38 | 39 - 48 | ≥ 49 |
| Female | ≤ 19 | 20 - 27 | 28 - 33 | 34 - 44 | ≥ 45 |
| 40-49 years | | | | | |
| Male | ≤ 19 | 20 - 26 | 27 - 35 | 36 - 44 | ≥ 45 |
| Female | ≤ 16 | 17 - 23 | 24 - 30 | 31 - 41 | ≥ 42 |
| 50-59 years | | | | | |
| Male | ≤ 17 | 18 - 24 | 25 - 33 | 34 - 42 | ≥ 43 |
| Female | ≤ 14 | 15 - 20 | 21 - 27 | 28 - 37 | ≥ 38 |
| 60-69 years | | | | | |
| Male | ≤ 15 | 16 - 22 | 23 - 30 | 31 - 40 | ≥ 41 |
| Female | ≤ 12 | 13 - 17 | 18 - 23 | 24 - 34 | ≥ 35 |

# Strength, force

Ability to carry out work against a resistance (internal, external). Strength is the maximal force you can apply against a load.

Forms:

- Maximal strength
- Relative strength
- Explosive strength
- Force endurance
- etc.

References: http://tamop-sport.ttk.pte.hu/files/tananyagfejlesztes/motorikus-kepessegek-merese.pdf
Sheppard JM, Young WB. (2005). Agility literature review: classifications, training and testing. J Sports Sci. 2006 Sep;24(9):919-32.

# Strength measurements

- Field tests E.g.: 1RM test – one repetition maximum test

https://www.youtube.com/watch?v=kORJnq0nP5g

- Laboratory measurements E.g.: Hand grip strength

https://www.youtube.com/watch?v=hBPfDbUW7Iw

References: http://tamop-sport.ttk.pte.hu/files/tananyagfejlesztes/motorikus-kepessegek-merese.pdf
https://www.hprc-online.org/physical-fitness/training-performance/what-one-rep-max

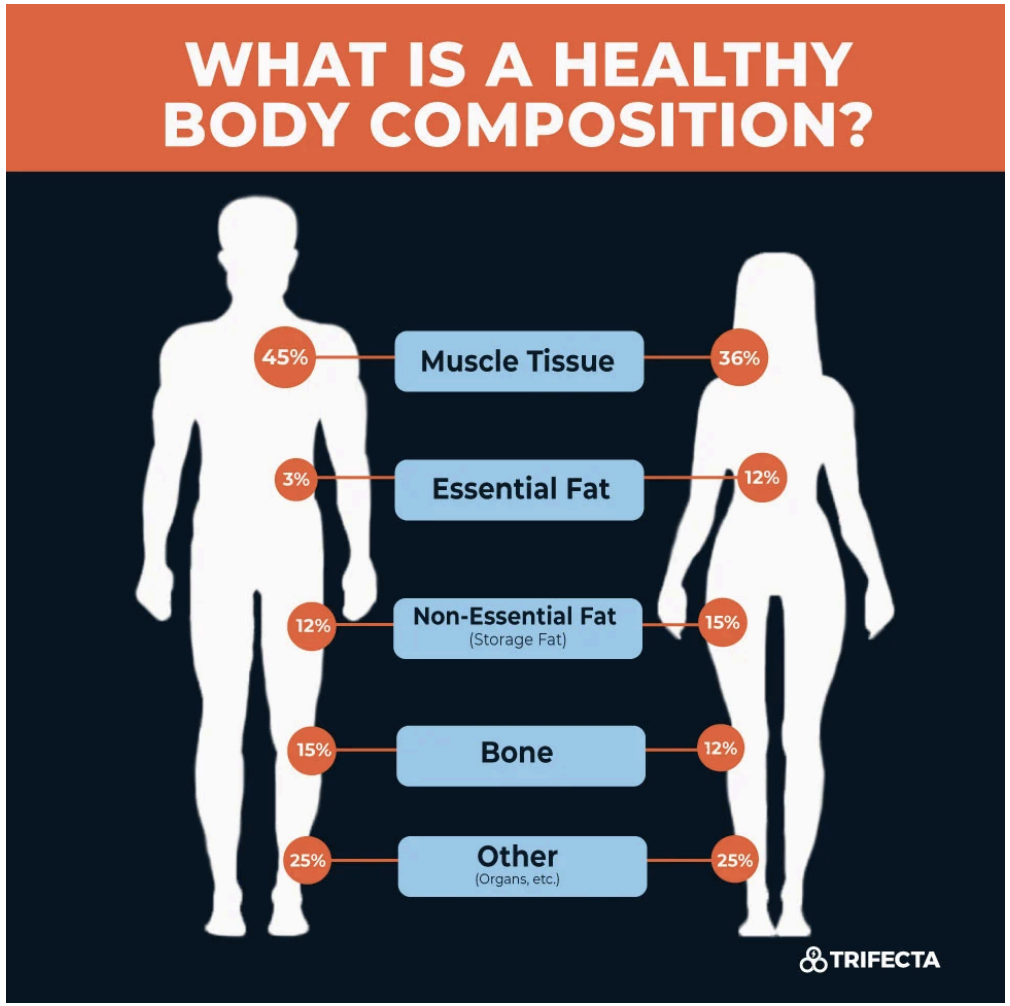
# Hand grip strength categories (expressed in kg)

| Age / Gender | Weak | Below Average | Average | Good | Excellent |
|---|---|---|---|---|---|
| **20-29 years** | Male: ≤ 24<br>Female: ≤ 23 | Male: 25-33<br>Female: 24-30 | Male: 34-42<br>Female: 31-37 | Male: 43-52<br>Female: 38-48 | Male: ≥ 53<br>Female: ≥ 49 |
| **30-39 years** | Male: ≤ 22<br>Female: ≤ 19 | Male: 23-30<br>Female: 20-27 | Male: 31-38<br>Female: 28-33 | Male: 39-48<br>Female: 34-44 | Male: ≥ 49<br>Female: ≥ 45 |
| **40-49 years** | Male: ≤ 19<br>Female: ≤ 16 | Male: 20-26<br>Female: 17-23 | Male: 27-35<br>Female: 24-30 | Male: 36-44<br>Female: 31-41 | Male: ≥ 45<br>Female: ≥ 42 |
| **50-59 years** | Male: ≤ 17<br>Female: ≤ 14 | Male: 18-24<br>Female: 15-20 | Male: 25-33<br>Female: 21-27 | Male: 34-42<br>Female: 28-37 | Male: ≥ 43<br>Female: ≥ 38 |
| **60-69 years** | Male: ≤ 15<br>Female: ≤ 12 | Male: 16-22<br>Female: 13-17 | Male: 23-30<br>Female: 18-23 | Male: 31-40<br>Female: 24-34 | Male: ≥ 41<br>Female: ≥ 35 |

# Body composition, sport specific anthropometry

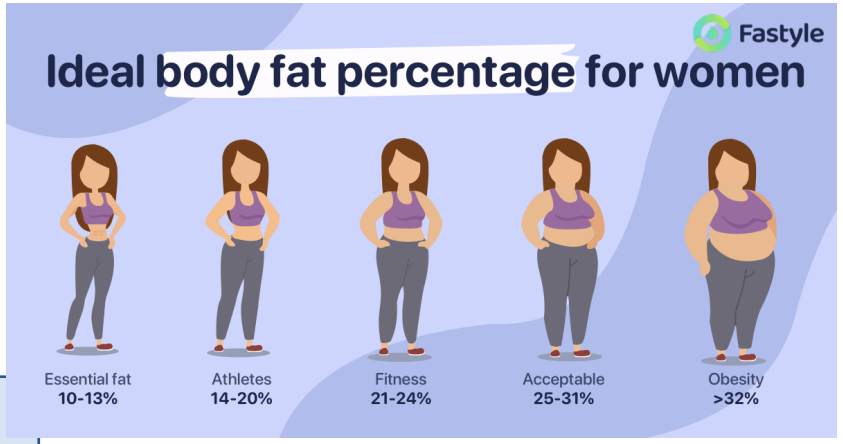
Sport specific anthropometry: investigate the relationship between sports performance and body composition, and characterize the somatotype of athletes at different ages.

Body composition: it describes the percentages of fat, bone and muscle in human bodies




Refernces: http://tamop-sport.ttk.pte.hu/files/tananyagfejlesztes/motorikus-kepessegek-merese.pdf
Mészáros J, Mohácsi J, Szabó T, Szmodis I (2000) Acta Biologica Szegediensis 44(1-4):189-192.
https://www.trifectanutrition.com/blog/what-is-body-composition-and-how-to-measure-it

# Body composition measurements




- Non-laboratory measurements

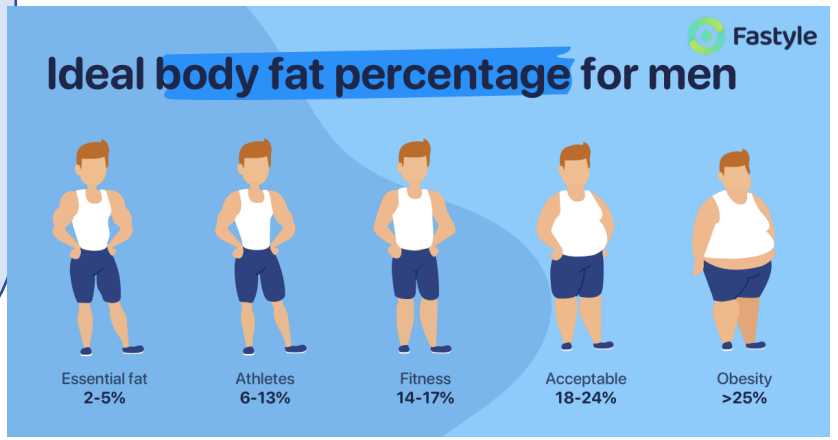
E.g. Body fat percent estimation with Lange caliper

https://www.youtube.com/watch?v=msMg9rkM4DU

- Laboratory measurements

E.g. Body fat percent estimation with bioimpedance analisys

https://www.youtube.com/watch?v=c3SDVlhe8HQ




References: http://tamop-sport.ttk.pte.hu/files/tananyagfejlesztes/motorikus-kepessegek-merese.pdf
https://www.fastyle.me/blog/why-people-of-the-same-weight-have-different-body-shapes/

# Body fat percent estimation (Lean et al, 1996)

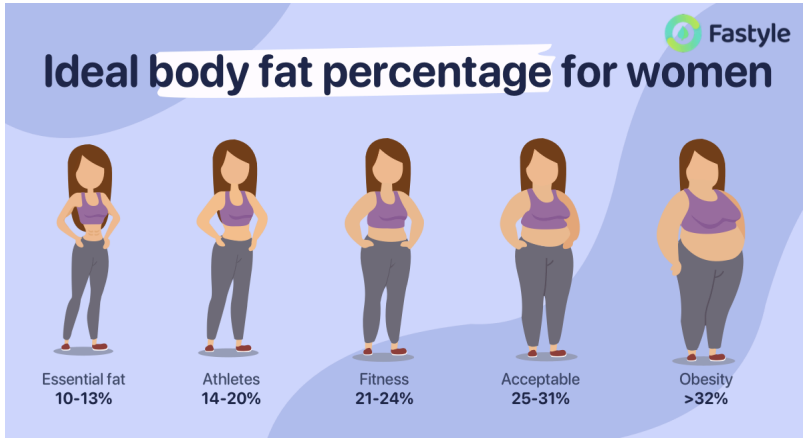
The first step is to calculate the body mass index (BMI, kg/m2) and measure the triceps skinfold thickness (mm).

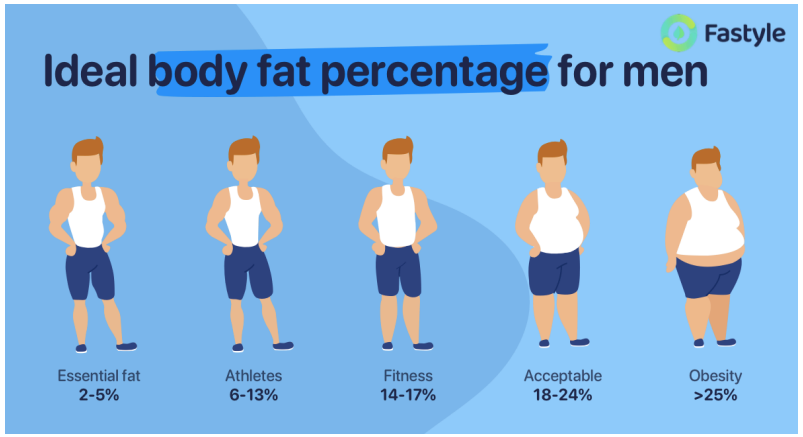
- **Formula for women:**

Body fat percentage = (0.730 x BMI) + (0.548 x triceps skinfold (mm)) + (0.270 x age (years)) – 5.9

- **Formula for men:**

Body fat percentage = (0.742 x BMI) + (0.950 x triceps skinfold (mm)) + (0.335 x age (years)) – 20




Reference: https://tamop-sport.ttk.pte.hu/tananyagfejlesztes/motorikus-kepessegek-merese/03

# Work of the sportscientist


https://www.youtube.com/watch?v=v9s0d5bazS0

UNIVERSITY OF PÉCS
MEDICAL SCHOOL

# Thank you for your attention.


## PTE902

http://potecho.pte.hu

spring semester 2026, Pécs