UNIVERSITY OF PÉCS
MEDICAL SCHOOL

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PTE ÁOK SPORTMEDICINA TANSZÉK

Bests of athletic performance
Lecture 2

POTEcho

PTE743

http://potecho.pte.hu

Eva Tékus (PhD)

fall semester 2025, Pécs

Requirements, recommended literature

Result of the test (%)	Grade
100-85	5
84-75	4
74-65	3
64-50	2
0-49	1

- 25 % absence is allowed
- Examination: written test (simple choice, true false questions)

  Lessons:

  - 09/10/2024; 16/10/2024; 30/10/2024; 06/11/2024

  Room: SIOT1015

  Presentations: homepage of Sports Medicine Center (Educational materials)

- Recommended literature:

  1. Cooper C.B, Storer T.W. Exercise testing and interpretation. A practical approach. Cambrige University Press, Cambrige, 2004
  2. Katch V.L., McArdle W.D., Katch F.I. Essentials of exercise physiology. Lippincott Williams & Wilkins, a Wolters Kluwer business, Philadelphia, USA, 2011

The most resilient athlestes

Physical performance - Classification of physical abilities

Conditional physical abilities:

1.Resiliance / Endurance

2. Force

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

Resilience, 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. $\dot{V}O_{2max}$ 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

Sports where endurance is very important (endurance sports)

Ranking	Sport	Rating (%)
1.	Orienteering	85.5
2.	Triathlon	85.5
3.	Rowing	85.3
4.	Water Polo	84.1
5.	Ultimate frisbee	83.2
6.	Swimming (200m Free)	80.8
7.	Ultra Marathon	80.5
8.	Road Cycling	79.9
9.	Squash	79.0
10.	Boxing	78.8

References: https://www.topendsports.com/fitness/sports/endurance-tes.htm

The most resilient athletes I.– marathon (42.195km)

Current world record: Kelvin Kiptum (1999-2024)
2:00:35, Chicago Marathon 2023

He holds three of the seven fastest marathons in history.
Kiptum won all three marathons he ran.

Rank	Mark	WIND	Competitor	DOB		Pos	Venue	Date	Results Score
1	2:02:27		Sabastian Kimaru SAWE	16 MAR 1995	KEN	1	London (GBR)	27 APR 2025	1271
2	2:03:23		Tadese TAKELE	03 AUG 2002	ETH	1	Tokyo (JPN)	02 MAR 2025	1253
3	2:03:37		Jacob KIPLIMO	14 NOV 2000	UGA	2	London (GBR)	27 APR 2025	1249
4	2:03:46		Amos KIPRUTO	16 SEP 1992	KEN	1	Hamburg (GER)	27 APR 2025	1246
5	2:03:51		Deresa GELETA	14 JAN 1996	ETH	2	Tokyo (JPN)	02 MAR 2025	1244

https://www.youtube.com/watch?v=sIoHbNL-o20

References: https://hu.wikipedia.org/wiki/Kelvin_Kiptum
https://www.runnersworld.com/races-places/a20823734/these-are-the-worlds-fastest-marathoners-and-marathon-courses/

The most resilient athletes II. – marathon

Current world record: Ruth Chepnhetich (2:09:56), who she set a women's world record at the Chicago marathon in 2024.

Rank	Mark	WIND	Competitor	DOB		Pos	Venue	Date	Results Score
1	2:09:56		Ruth CHEPNGETICH	08 AUG 1994	KEN	1	Chicago, IL (USA)	13 OCT 2024	1312
2	2:11:53		Tigst ASSEFA	03 DEC 1996	ETH	1	Berlin (GER)	24 SEP 2023	1292
3	2:13:44		Sifan HASSAN	01 JAN 1993	NED	1	Chicago, IL (USA)	08 OCT 2023	1274
4	2:14:04		Brigid KOSGEI	20 FEB 1994	KEN	1	Chicago, IL (USA)	13 OCT 2019	1270
5	2:14:58		Amane Beriso SHANKULE	13 OCT 1991	ETH	1	Valencia (ESP)	04 DEC 2022	1262

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

References: https://worldathletics.org/records/all-time-toplists/road-running/marathon/outdoor/women/senior

24 hours record: Kilian Jornet: https://www.youtube.com/watch?v=MRzeLDkWT1c

The most resilient athletes III. – ultramarathon runners

Legendary peak holders: Yiannis Kouros

He holds many men's outdoor road world records from 100 to 1,000 miles and many road and track records from 12 hours to 6 days.

Event	Record	Athlete	Date	Place
50 km	2:42:07	Ketema Bekele Negasa (ETH)	23 May 2021	Port Elizabeth, South Africa
50 miles	4:50:08	Jim Walmsley (USA)	4 May 2019	Sacramento, USA
100 km	6:05:41	Aleksandr Sorokin (LTU)	23 Apr 2022	Bedford, UK
100 miles	10:51:39	Aleksandr Sorokin (LTU)	7 Jan 2022	Tel Aviv, Israel
1000 km	5d 16:17:00	Yiannis Kouros (GRE)	26 Nov–2 Dec 1984	Colac, Australia
1000 miles	10d 10:30:36	Yiannis Kouros (GRE)	20–30 May 1988	New York City, USA
6 hours	98.496 km	Aleksandr Sorokin (LTU)	23 Apr 2022	Bedford, UK
12 hours	177.410 km	Aleksandr Sorokin (LTU)	7 Jan 2022	Tel Aviv, Israel
24 hours	309.339 km[a]	Aleksandr Sorokin (LTU)	28 Aug 2021	Pabianice, Poland
48 hours	473.495 km	Yiannis Kouros (GRE)	3–5 May 1996	Surgères, France
6 days	1036.800 km	Yiannis Kouros (AUS)[b]	20–26 Nov 2005	Colac, Australia

References: https://en.wikipedia.org/wiki/Ultramarathon
https://en.wikipedia.org/wiki/Yiannis_Kouros

The most resilient athletes IV. – ultramarathon runners

Legendary peak holders: Sandra Barwick

She is a New Zealand ultramarathon runner who set a new six-day track world record in Campbelltown, Australia, 18–24 November 1990.

Event	Record	Athlete	Date	Place
50 km	2:59:54	Desiree Linden (USA)	13 April 2021	Dorena, Oregon, United States
50 miles	5:40:18	Ann Trason (USA)	23 Feb 1991	Houston, USA
100 km	6:33:11	Tomoe Abe (JPN)	25 Jun 2000	Yubetsu-Saroma-Tokoro, Japan
100 miles	12:42:40	Camille Herron (USA)	11 Nov 2017	Vienna, IL, USA
1000 km	7d 16:08:37	Paula Mairer (AUT)	29 Sep-6 Oct 2002	New York City, USA
1000 miles	12d 14:38:40	Sandra Barwick (NZL)	18–28 Oct 1991	New York City, USA
6 hours	85.492km	Nele Alder-Baerens (GER)	11 Mar 2017	Münster, Germany
12 hours	149.130 km	Camille Herron (USA)	9–10 Dec 2017	Phoenix, Arizona, USA
24 hours	270.116 km	Camille Herron (USA)	26–27 Oct 2019	Albi, France
48 hours	397.103 km	Sumie Inagaki (JPN)	21–23 May 2010	Surgères, France
6 days	883.631 km	Sandra Barwick (NZL)	18–24 Nov 1990	Campbelltown, Australia

References: https://en.wikipedia.org/wiki/Ultramarathon
https://en.wikipedia.org/wiki/Sandy_Barwick

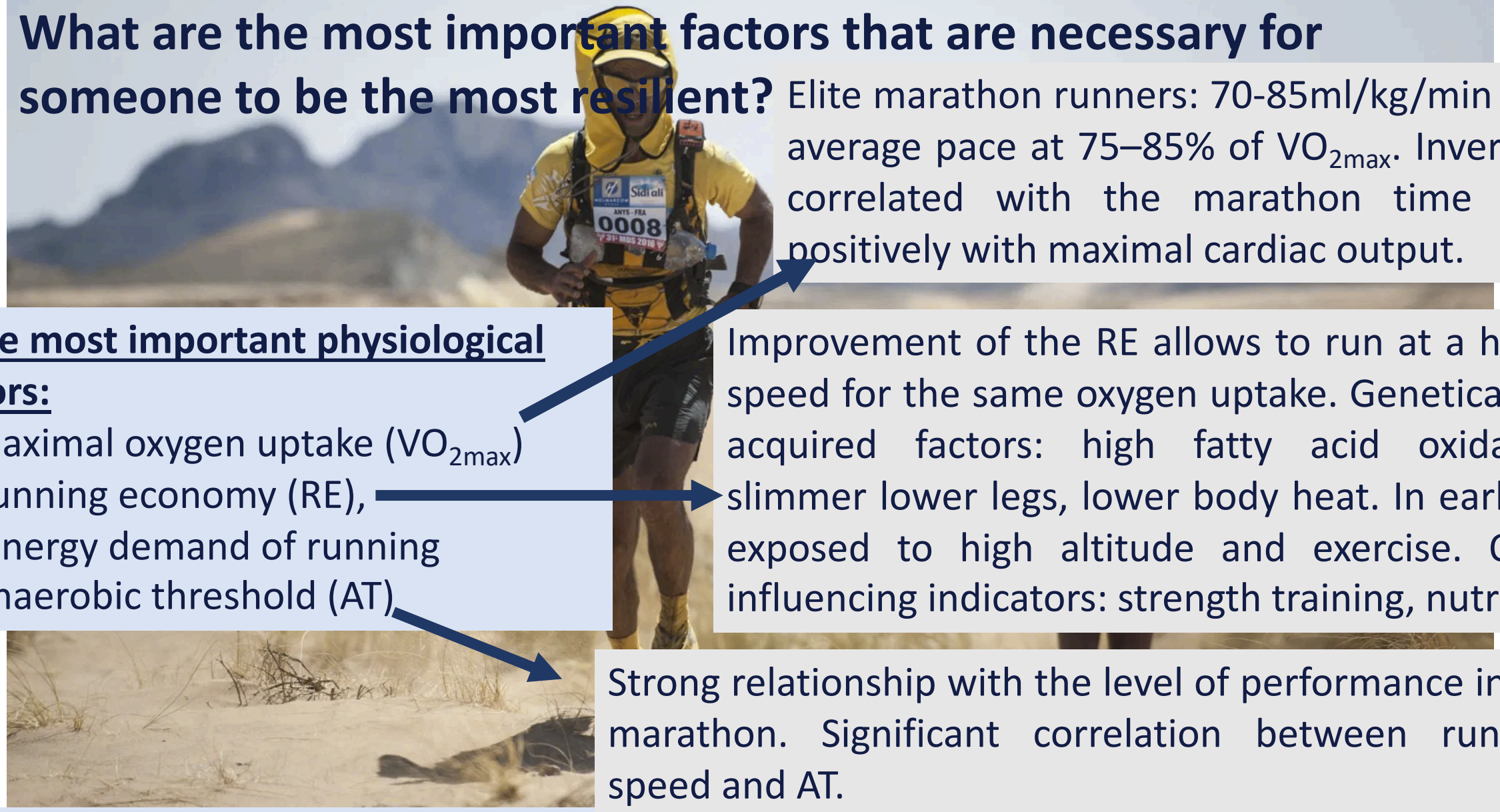
Group work

Group 1: At what age can the greatest endurance performance be expected? Why?

Group 2: Are there differences betwen genders in endurance performance? If yes, what causes it?

Group 3: What are the most important characteristics of successful endurance athletes?

What are the most important factors that are necessary for someone to be the most resilient?



Elite marathon runners: 70-85ml/kg/min and average pace at 75–85% of VO_{2max}. Inversely correlated with the marathon time and positively with maximal cardiac output.

<u>Three most important physiological factors:</u>

- Maximal oxygen uptake (VO_{2max})
- Running economy (RE),

i.e. energy demand of running

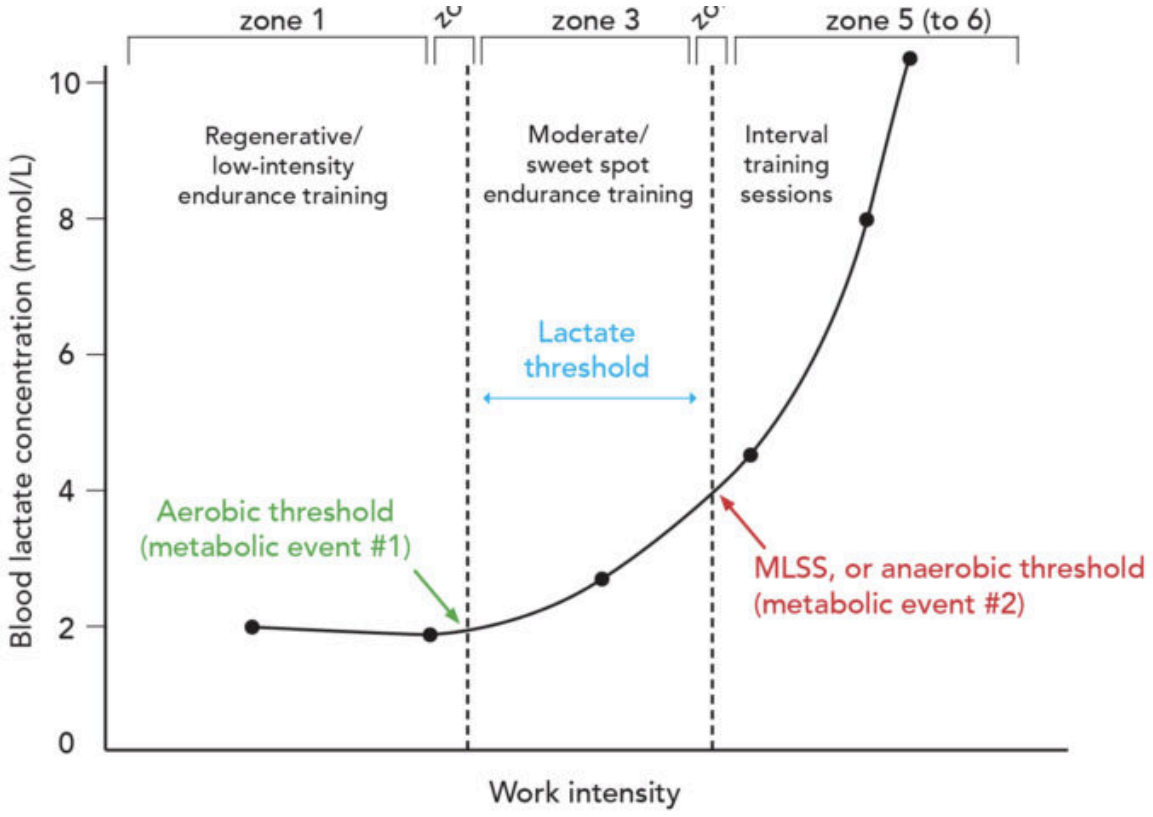
- Anaerobic threshold (AT)

Improvement of the RE allows to run at a higher speed for the same oxygen uptake. Genetical and acquired factors: high fatty acid oxidation, slimmer lower legs, lower body heat. In early life exposed to high altitude and exercise. Other influencing indicators: strength training, nutrition.

Strong relationship with the level of performance in the marathon. Significant correlation between running speed and AT.

Refernce: Venturini, E., & Giallauria, F. (2022). Frontiers in cardiovascular medicine, 9, 856875., https://www.horizonsports.com/the-marathon-des-sables-on-horizonsports-tv/

Thresholds



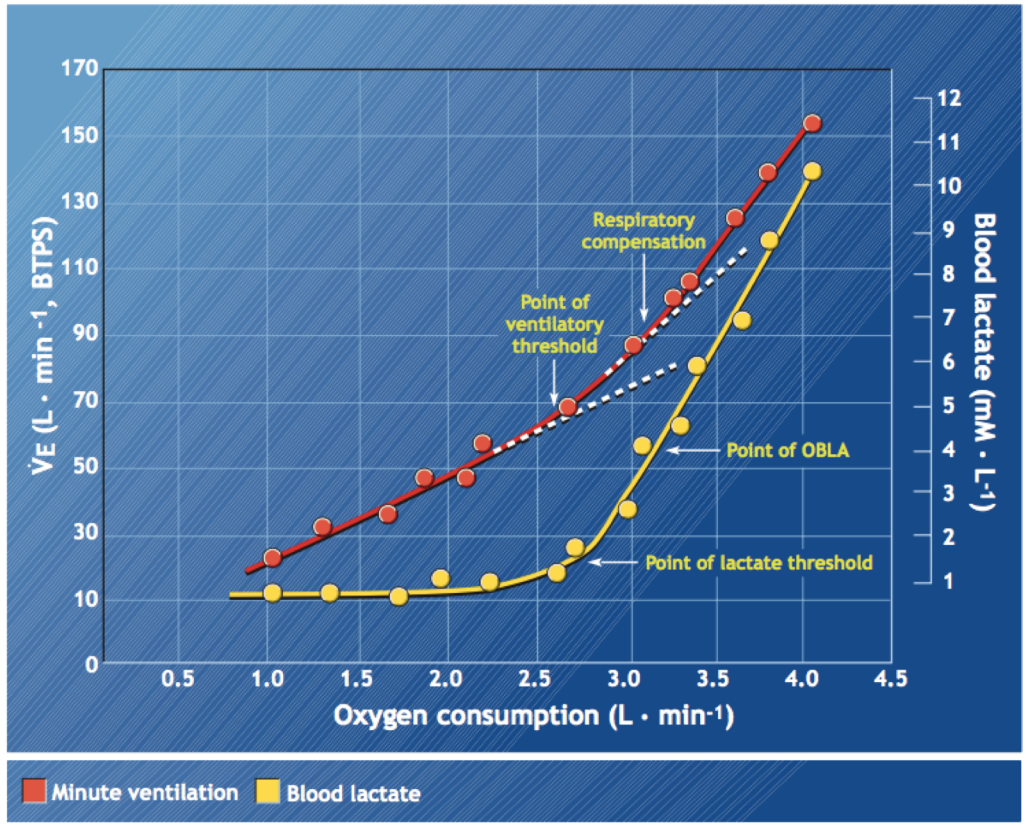
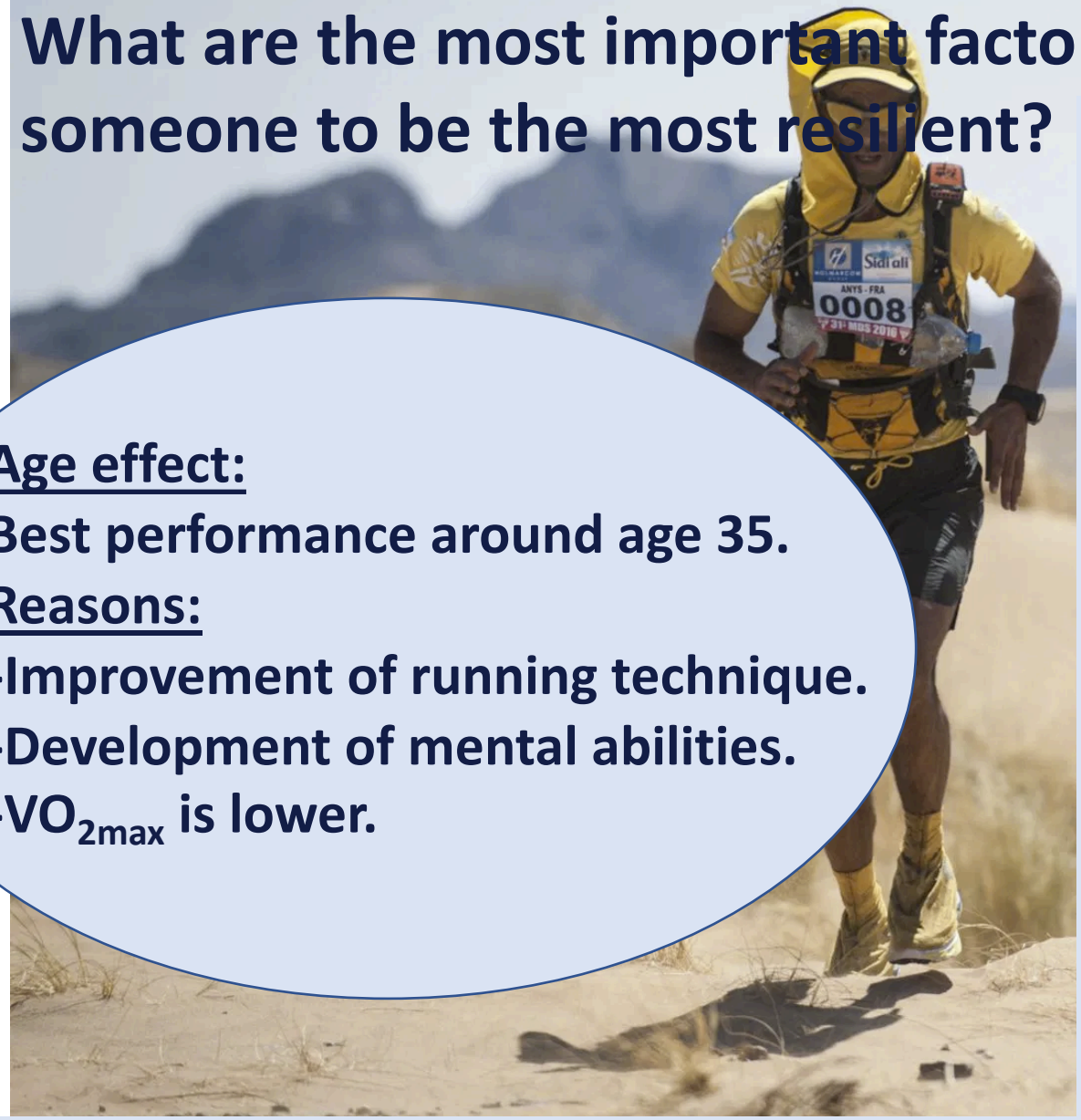


Figure 9.15 Pulmonary ventilation, blood lactate concentration, and oxygen consumption during graded exercise to maximum. The *lower dashed white line* extrapolates the linear relationship between $\dot{V}_E$ and $\dot{V}O_2$ during submaximal exercise. The lactate threshold (not necessarily the threshold for anaerobic metabolism) represents the highest exercise intensity (oxygen consumption) not associated with elevated blood lactate concentration. It occurs at the point at which the relationship between $\dot{V}_E$ and $\dot{V}O_2$ deviates from linearity, indicated as the point of ventilatory threshold. The onset of blood lactate accumulation (OBLA) represents the point of lactate increase just above a 4.0-mM baseline. Respiratory compensation represents a further disproportionate increase in ventilation (indicated by deviation from *the upper dashed white line*) to counter the decrease in plasma pH in intense exercise.

Reference: Katch V.L., McArdle W.D., Katch F.I. Essentials of exercise physiology. Lippincott Williams & Wilkins, a Wolters Kluwer business, Philadelphia, USA, 2011, https://www.fasttalklabs.com/tag/aerobic-threshold/

What are the most important factors that are necessary for someone to be the most resilient?



Age effect:

Best performance around age 35.

Reasons:

-Improvement of running technique.

-Development of mental abilities.

-VO_{2max} is lower.

Other influencing factors:

- Topographic factors (topography, Berlin)
- Climatic conditions (temperature, wind)
- Season, daytime
- Air pollution (PM10)
- Running in a protected position (drafting, IAAF violation)
- Steady running pace
- Advances in Shoe Technology (NAST)
- Origin (East African runners: anthropometry, muscle fiber composition, prize money)
- Gender differences (muscle mass, heart size, body fat, hemoglobin concentration, VO_{2max})

Reference: Venturini, E., & Giallauria, F. (2022). Frontiers in cardiovascular mec
sables-on-horizonsports-tv/

The most skillful, the most accurate athletes

Skillfulness, accuracy

Skillful: Having the ability to perform well: able, capable, competent, good, skilled under high pressure and under competitive conditions.

Accuracy: the ability to control movement in a given direction or at a given intensity.

Skillfulness and technique of Ronaldo (28:30)
https://www.youtube.com/watch?v=0k2ey_okQ4E
https://www.youtube.com/watch?v=tU16fvTaK3U

Refernces: http://tamop-sport.ttk.pte.hu/files/tananyagfejlesztes/motorikus-kepessegek-merese.pdf.
https://sportresilience.com/accuracy/

Measuring skillfulness and accuracy

- Field tests E.g. Pin Point Accuracy (in Tennis)

https://www.youtube.com/watch?v=o0PQoiBRXJQ

- Laboratory measurement E.g. Accuracy of the throwing (American football)

https://www.youtube.com/watch?v=tVoqA-LKGb4
(1:45)

Reference: http://tamop-sport.ttk.pte.hu/files/tananyagfejlesztes/motorikus-kepessegek-merese.pdf

Sports, where is essential the skillfulness and the accuracy

1. Golf
2. Boxing
3. Ice hockey
4. Mixed martial arts
5. Tennis
6. Gymnastics
7. Hurling
8. Soccer
9. Water polo
10. Rugby

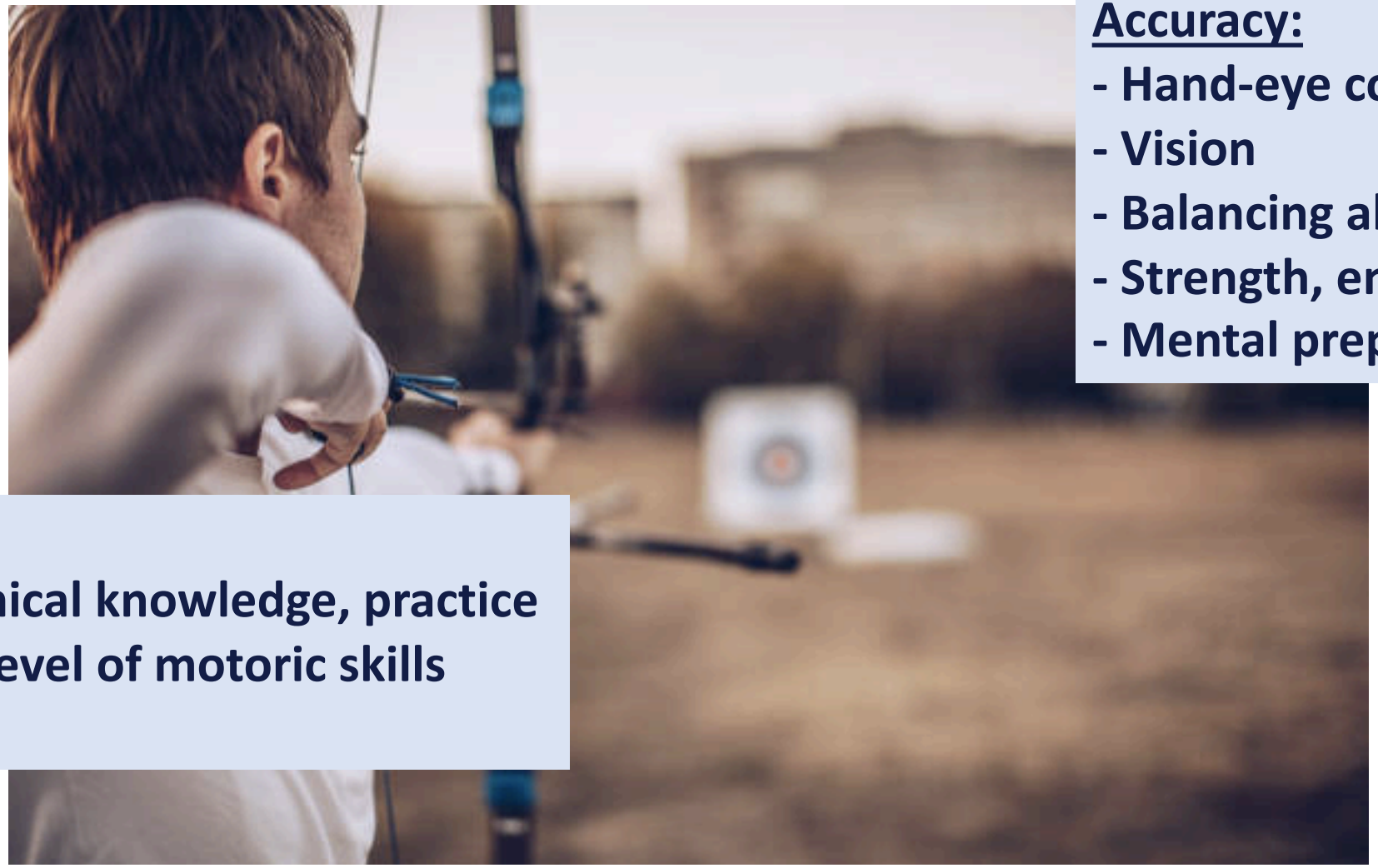
1. Billiards
2. Golf
3. Archery
4. Rifle, pistol, and shotgun shooting

References: https://www.pledgesports.org/2018/03/what-are-the-most-skilful-sports/
https://www.lasikmd.com/blog/a-fine-line-four-sports-that-demand-precision

The most skillful, the most accurate athletes

https://www.youtube.com/watch?v=VltAgg2H-HE

What skills are necessary for someone to be the most accurate and skillful athletes?



Accuracy:
- Hand-eye coordination
- Vision
- Balancing ability
- Strength, endurance
- Mental preparation

Skillfulness:
- Sport technical knowledge, practice
- Adequate level of motoric skills
- Creativity

Reference: https://www.istockphoto.com/hu/fot%C3%B3k/archery-sport,
Richard, V., Abdulla, A. M., & Runco, M. A. (2017). Journal of Genius and Eminence, 2(1), 65-76.

The most flexible athletes

Flexibility, range of motion (ROM)

Flexibility: the ability that means the mobility of the muscles, the ligaments and the joints together.

ROM: degree, the subject can move the joint voluntarily.

The most flexible athletes:
https://www.youtube.com/watch?v=h7ewRr2C7jo

Types (ROM):
- Physiologic range of motion (ROM)
- Non-physiologic ROM

- Active
- Passive

Forrás: 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.

Measuring flexibility

- Field test E.g. Sit and reach test

https://www.youtube.com/watch?v=TgaGCX20UlQ

https://www.youtube.com/watch?v=ycMPXvq5Ejw (9:40)

References: http://tamop-sport.ttk.pte.hu/files/tananyagfejlesztes/motorikus-kepessegek-merese.pdf
https://testsforsports.com/flexibility/sit-and-reach-test

Sports, where important the flexibility (sports requiring flexibility)

Ranking	Sport	Rating (/10)
1.	Gymnastics	10.00
2.	Diving	8.50
3.	Figure skating	8.25
4.	Wrestling	7.50
5.	Cheerleading	7.50
6.	Martial arts	7.00
7.	Track and Field: Pole Vault	7.00
8.	Skiing (freestyle)	6.88
9.	Track and Field: High Jump	6.63
10.	Racquetball/Squash	5.88

References: http://tamop-sport.ttk.pte.hu/files/tananyagfejlesztes/motorikus-kepessegek-merese.pdf
https://www.topendsports.com/fitness/sports/flexibility-espn.htm

The most flexible athletes I. – Artistic gymnastics

Olympic Games 2024 individual winner: Simone Biles

Six-times Olympic champion, twenty-three times world champion.

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

References: https://hu.wikipedia.org/wiki/Simone_Biles
https://www.facebook.com/simonebiles/?locale=hu_HU

The most flexible athletes II. – Artistic gymnastics

Gymnast with the most medals: Kōhei Uchimura

He is a 7x Olympic medalist (all-around, team and floor exercise), 21x World medalist (all-around, team, floor exercise, horizontal bar, and parallel bars).

https://www.youtube.com/watch?v=5m8WgS3LkG8

Reference: https://en.wikipedia.org/wiki/K%C5%8Dhei_Uchimura

Which factors can influence the flexibility, the range of motion?

- Genetic factors
- Anatomical structure of a joint
- Position and characteristics of tendons and ligaments
- Presence of other tissues (muscle, fat).
- Skin

- Muscle strength
- Muscle flexibility

- Gender
- Age

- Temperature / body temperature
- Daytime

- Previous injuries

Reference: Gleim, G. W., & McHugh, M. P. (1997). Sports medicine (Auckland, N.Z.), 24(5), 289–299.

Funny sport cases

https://www.youtube.com/watch?v=ZwQqkuUS1Nk

Reference: Reeves et al, 2018, A scoping review of the potential sociological predictors of talent in junior-elite football: 2000–2016. Soccer and Society

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Thank you for your attention!

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Kahoot!

https://create.kahoot.it/details/12226673-0dc0-4f52-a995-b9229ccbeb57