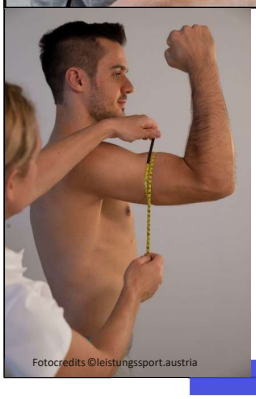
LEISTUNGSSPORT AUSTRIA

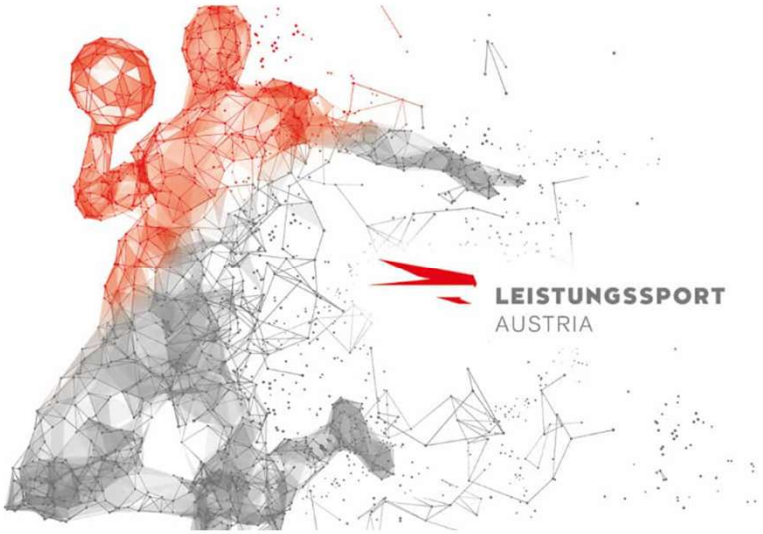


ANTHROPOMETRIE & KÖRPERZUSAMMENSETZUNG im SPORT – METHODENAUSWAHL in THEORIE und PRAXIS

Mag.ª Dr.in MARIETTA SENGEIS
m.sengeis@leistungssport.at
+43 664 8265364

ONLINE
25.09.2025
19:00-21:00 Uhr - mit anschließender Diskussion

1



LEISTUNGSSPORT AUSTRIA

Gefördert von
Bundesministerium Wohnen, Kunst, Kultur, Medien und Sport

2

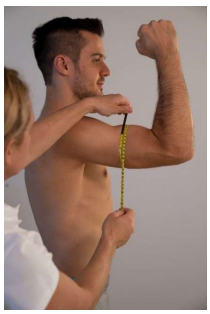
SPORTANTHROPOMETRIE

Anthropometrie: „Anthropos“ = Mensch; „metrie“= vermessen

LEISTUNGSSPORT AUSTRIA

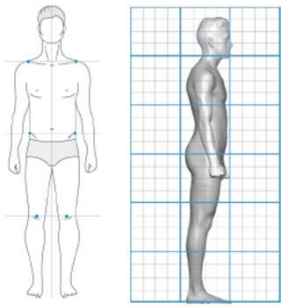
- >30 Jahren in Anwendung (LSA, vormals IMSB)
- ursprünglich - Kalipermetrie nach Best
- Erweiterungen – STANDARDISIERUNG: (ISAK) International Society for the Advancement of Kinanthropometrie
- Somatotyp (Muskelumfänge, Knochenbreiten, Hautfaltendicken) sowie Proportionen, Indizes
- Methodenwechsel: Messung von subkutanem – „Adipose Tissue“ mittels Ultraschalls – 3 D Körperanalyse

Anthropometrie unterliegt ständigen Erweiterungen und technischen Neuerungen, großes Forschungsinteresse,.....



SURFACE ANTHROPOMTRY according to the International Society for the Advancement of Kinanthropometry (ISAK).

ULTRASOUND according to the International Association for Science in Medicine and Sports (IASMS).



SCANECA **3D-KÖRPERANALYSE**

3

KÖRPERGEWICHT - KÖRPERZUSAMMENSETZUNG

Aesthetic sports

Weight–class sports

Gravitational sports

Ackland TR, Lohman TG, Sundgot-Borgen J, et al. Sports Med 2012;42:227–49.
Sundgot-Borgen J, Meyer NL, Lohman TG, et al. BJSM 2013;47:1012-1022.

4

Die Körperzusammensetzung hat einen Einfluss auf beides: LEISTUNG und GESUNDHEIT

Niedriges Körpergewicht/Körperfett kann in „gewichtssensiblen Sportarten“ einen Wettkampfvorteil verschaffen [1,2,3]:

Gravitational sports (Technical/Endurance):

Description: *„Sports in which high body mass (may) restricts performance due to mechanical (gravitational) reasons“* [4]

Sport examples: Long distance running, Ski jumping, Road cycling, Climbing, Jumping (high, pole)

Weight class sports:

Description: *„Sports in which athletic competitions are organised according to categories of body mass because the athletes anticipate an advantage when they are classified in a lower body mass (weight) category“* [4]

Sport examples: Wrestling, Judo, Boxing, Taekwondo, Weight lifting, Leightweight rowing, Jockeying

Aesthetic sports:

Description: *„Sports in which athletes or their coaches expect higher scores when their body mass and shape conform to a perceived body ideal. This group includes particularly the judged female sports“* [4]

Sport examples: Rhythmic and artistic gymnastics, Figure skating, synchronised swimming

! Körperfett ist ein wichtiges endokrines Organ (nicht nur Ballastgewicht) ! [5]

[1]Ackland T. et al. SportsMed, 2012, [2] Sundgot B. et al. BJSM, 2013,
[3] Müller W. et al., BJSM, 2016, [4] Meyer NL. et al. BJSM, 2013, [5] Goralski KB, and Sinal CJ, 2010.

5

Gewichtsklassen im JUDO

Beispiel

WC		MEN	WOMEN
Extra lightweight	1	– 60 kg	– 48 kg
Half-lightweight	2	– 66 kg	– 52 kg
Lightweight	3	– 73 kg	– 57 kg
Half-middleweight	4	– 81 kg	– 63 kg
Middleweight	5	– 90 kg	– 70 kg
Half-heavyweight	6	– 100 kg	– 78 kg
Heavyweight	7	+ 100 kg	+ 78 kg

https://judoinfo.com/olympic3/ (April 2024)

6

REVIEW ARTICLE

Current Status of Body Composition Assessment in Sport

Review and Position Statement on Behalf of the Ad Hoc Research Working Group on Body Composition, Health and Performance, Under the Auspices of the I.O.C. Medical Commission

Timothy R. Ackland,[1] Timothy G. Lohman,[2] Jorunn Sundgot-Borgen,[3] Ronald J. Maughan,[4] Nanna L. Meyer,[5] Arthur D. Stewart[6] and Wolfram Müller[7]

Br J Sports Med. 2013 Nov;47(16):1044-53. doi: 10.1136/bjsports-2013-092561. Epub 2013 Sep 24.

Body composition for health and performance: a survey of body composition assessment practice carried out by the Ad Hoc Research Working Group on Body Composition, Health and Performance under the auspices of the IOC Medical Commission

Nanna L Meyer [1], Jorunn Sundgot-Borgen, Timothy G Lohman, Timothy R Ackland, Arthur D Stewart, Ronald J Maughan, Suzanne Smith, Wolfram Müller

"IOC Concerned about Body Composition, Health and Performance of Athletes"

Consensus statement

How to minimise the health risks to athletes who compete in weight-sensitive sports review and position statement on behalf of the Ad Hoc Research Working Group on Body Composition, Health and Performance, under the auspices of the IOC Medical Commission

Jorunn Sundgot-Borgen,[1] Nanna L Meyer,[2] Timothy G Lohman,[3] Timothy R Ackland,[4] Ronald J Maughan,[5] Arthur D Stewart,[6] Wolfram Müller[7]

Br J Sports Med: first published as 10.1136/bjspor

Sports Medicine (2020) 50:597–614
https://doi.org/10.1007/s40279-019-01192-9

ORIGINAL RESEARCH ARTICLE

Relative Body Weight and Standardised Brightness-Mode Ultrasound Measurement of Subcutaneous Fat in Athletes: An International Multicentre Reliability Study, Under the Auspices of the IOC Medical Commission

Wolfram Müller[1] · Alfred Fürhapter-Rieger[1] · Helmut Ahammer[1] · Timothy G. Lohman[2] · Nanna L. Meyer[3] · Luis B. Sardinha[4] · Arthur D. Stewart[5] · Ronald J. Maughan[6] · Jorunn Sundgot-Borgen[7] · Tom Müller[1] · Margaret Harris[8] · Nuwanee Kirihennedige[3] · Joao P. Magalhaes[4] · Xavier Melo[4] · Wolfram Pirstinger[1] · Alba Reguant-Closa[3] · Vanessa Risoul-Salas[3] · Timothy R. Ackland[8]

Original article

Subcutaneous fat patterning in athletes: selection of appropriate sites and standardisation of a novel ultrasound measurement technique: ad hoc working group on body composition, health and performance, under the auspices of the IOC Medical Commission

Wolfram Müller,[1] Timothy G Lohman,[2] Arthur D Stewart,[3] Ronald J Maughan,[4] Nanna L Meyer,[5] Luis R Sardinha,[6] Nuwanee Kirihennedige,[7] Alba Reguant-Closa,[3] Vanessa Risoul-Salas,[3] Jorunn Sundgot-Borgen,[7] Helmut Ahammer,[1] Friedrich Anderhuber,[8] Alfred Fürhapter-Rieger,[1] Phillipp Kainz,[1] Wilfried Materna,[9] Ulrike Pilsl,[8] Wolfram Pirstinger,[1] Timothy R Ackland[10]

Br J Sports Med: first published as 10.1136/bjsports-2015-(

7

IADMS International Association for Dance Medicine & Science

RESOURCE FOR DANCERS AND TEACHERS

Nutrition Resource Paper

JASMINE CHALLIS RD, AND ADRIENNE STEVENS EDD, WITH THE IADMS DANCE EDUCATORS' COMMITTEE, 2016, AND UPDATED IN 2019

"Raising awareness about low energy availability and relative energy deficiency in dance and sport was the rationale for writing the British Association of Sport and Exercise Medicine open access, educational website"

[1]. https://blogs.bmj.com/bjsm/2020/12/30/energy-availability-in-dancers/ (29.11.2022)

IADMS International Association for Dance Medicine & Science

RESOURCE PAPER FOR DANCERS AND TEACHERS

Bone Health and female dancers: Physical and nutritional guidelines

BONNIE ROBSON AND ARLENE CHERTOFF WITH THE IADMS DANCE EDUCATORS' COMMITTEE, 2018.

IADMS International Association for Dance Medicine & Science

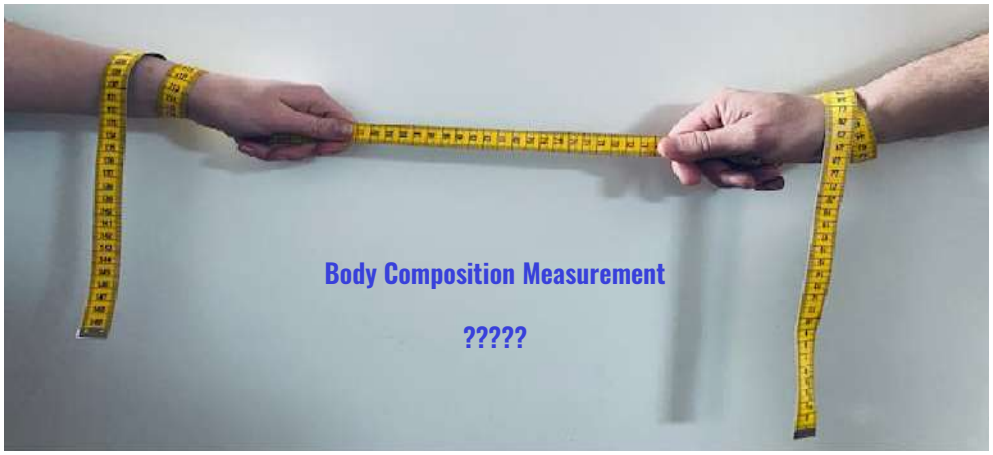
RESOURCE PAPER FOR DANCERS AND TEACHERS

The Challenge of the Adolescent Dancer

KATHYRN DANIELS WITH THE IADMS DANCE EDUCATORS' COMMITTEE, 2000.

[1] www.health4performance.co.uk BASEM educational website

8



9

“Häufig verwendete BC-Methoden (im Sport)” bis 2013

Methode	Amerika	Europa	Ozeanien	Andere
ISAK skinfolds (%)	24	47	82	54
Other skinfolds (%)	34	51	25	23
BIA (%)	15	42	14	15
ADP (%)	15	11	11	15
Hydrostatic Weighing (%)	7	9	7	0
DXA (%)	23	35	43	31

Adaptiert aus: Meyer N. et al. BJSM, 2013

Abbreviations: (BC) Body composition, (BIA) bioelectrical impedance analysis, (DXA) dual-energy X-ray absorptiometry, (ADP) air displacement plethysmography, ISAK, skinfold assessment according to the International Society for the Advancement of Kinanthropometry.

Br J Sports Med. 2013 Nov;47(16):1044-53. doi: 10.1136/bjsports-2013-092561. Epub 2013 Sep 24.

Body composition for health and performance: a survey of body composition assessment practice carried out by the Ad Hoc Research Working Group on Body Composition, Health and Performance under the auspices of the IOC Medical Commission

Nanna L Meyer [1], Jorunn Sundgot-Borgen, Timothy G Lohman, Timothy R Ackland, Arthur D Stewart, Ronald J Maughan, Suzanne Smith, Wolfram Müller

- ❑ Elektronischer Fragebogen: 2013
  - 188 Feedbackbögen von Fachexperten
  - 33 Länder
  - Leistungssport

10

Wie wird die Körperzusammensetzung im Sport aktuell gemessen?

Methode	Kommentare
ISAK skinfolds	Weiterhin weit verbreitet und in Verwendung
Skinfolds Fett in %-Berechnung	minus 40% im Vergleich zu 2013
Ultraschall, ADP, Hydrostatic Weighting	Anwendung: unter 10% der befragten Anwender
DXA (%)	+ 11%
BIA	wie 2013

Mathisen TF. et al. BJSM, 2023

Abbreviations: (BIA) bioelectrical impedance analysis, (DXA) dual-energy X-ray absorptiometry, (ADP) air displacement plethysmography, ISAK, skinfold assessment according to the International Society for the Advancement of Kinanthropometry.

* Fachexperten wurden unterschiedlich zugeordnet (z.B. Messung für Gesundheit (n=10), Messung für Leistung (19)

- ❑ Anwendung von standardisierten Protokollen ist gestiegen (positiv)

Best practice recommendations for body composition considerations in sport to reduce health and performance risks: a critical review, original survey and expert opinion by a subgroup of the IOC consensus on Relative Energy Deficiency in Sport (REDs)

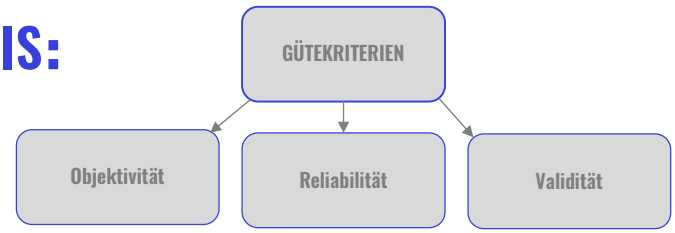
Therese Fostervold Mathisen ,[1] Timothy Ackland ,[2] Louise M Burke ,[3] Naama Constantini ,[4] Judith Haudum,[5] Lindsay S Macnaughton ,[5] Nanna L Meyer ,[7] Margo Mountjoy ,[8,9] Gary Slater ,[10] Jorunn Sundgot-Borgen [11]

Br J Sports Med: first published as 10.1136/bjsports-2023-

- ❑ Elektronischer Fragebogen: 2022
  - Fachexperten*
  - 26 Länder
  - Leistungssport

11

BASIS:



Objektivität:
Wenn das Untersuchungsergebnis in der Durchführung, Datenauswertung und Dateninterpretation unabhängig vom Untersucher gleich ist.

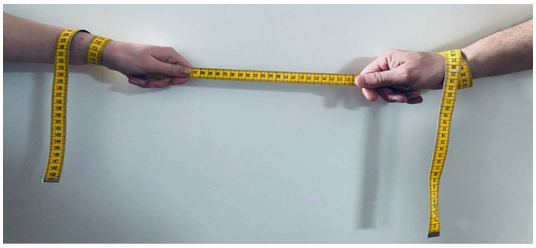
Reliabilität:
Zuverlässigkeit der angewandten Messmethode
Wiederholungsgenauigkeit (Reliabilitätskoeffizient 0,00-1,00: je höher desto reliabler)

Validität (Gültigkeit): misst das gewählte Verfahren, was es messen soll?

Genauigkeit (accuracy)!!! Beschreibt wie nah der Messwert am wahren Wert liegt – hohe Genauigkeit = richtiges Messergebnis (kein systematischer Messfehler (generell zu hoch oder generell zu niedrig)

12

Messprozedere standardisieren!!!



13

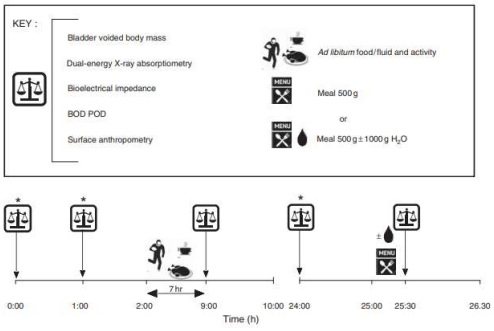
Von der Wissenschaft in die Sportpraxis

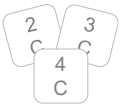
Beispiel: RECHERCHE

Kerr A., et al. Impact of food and fluid intake on technical and biological measurement error in body composition assessment methods in athletes. British Journal of Nutrition, 2017.

Purpose: to evaluate standardised (overnight fasted, rested and hydrated) versus non-standardised (afternoon and non-fasted) presentation on technical and biological error on:

Surface Anthropometry (SA)	Dual-energy X-ray absorptiometry (DXA)	Bioelectrical impedance spectroscopy (BIS)	Air displacement plethysmography (BOD POD)



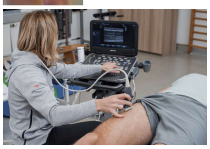


ATHLETES: 32 male athletes, at least 2 y resistance training (BMI ≥25 kgm^{-2})

14

Methoden, Merkmale, Stärken/Schwächen

Method (approach)	Outcome measures	Assumptions/cautions	Accuracy	Precision/repeatability (technically)*	Advantages	Limitations
Anthropometry (skinfolds) (anatomical)	Skinfold thickness (compressed) Skinfold sum Skinfold ratios Conversion to BF (%) via equations not supported[99]	Several assumptions are required,[99] including: Constant skinfold compressibility Constant SAT compressibility Constant skin thickness Unknown proportion of embedded fibrous structures	Unknown	Intra-tester 5% TEM for ISAK-trained, skilled technicians[100]	Applicable in the field Standardised protocols Data norms available Non-invasive and no radiation Scores are minimally affected by exercise, hydration or ingestion of food Cost efficient	Measurer training necessary Samples of the subcutaneous fat deposit only Some sites difficult to achieve Measures primarily skin thickness in lean persons Can be intrusive for some individuals Some site locations not scaled to body dimensions
Ultrasound (anatomical)	SAT thicknesses (uncompressed) with fibrous structures included and excluded SAT mass SAT patterning	No image distortion with a linear probe Use the speed of sound in SAT for distance determination Use standardised protocol[100] Correct detection of tissue layer boundaries need training and experience Analysis must avoid some anatomical structures (blood vessels)	Accuracy 0.1 mm (18 MHz probe); 0.2 mm (10 MHz)	95% LOA=0.2 mm (for the mean of eight sites), which translates to 0.2 kg SAT mass[102]	Applicable in the field Standardised protocols Non-invasive and no radiation Scores are minimally affected by exercise, hydration or ingestion of food[103] High accuracy and precision of measurement of subcutaneous fat Scan site locations relative to stature No tissue compression Tissue thickness 0.1–100 mm	Measurer training necessary Samples the subcutaneous fat deposit only Expensive equipment
Impedance (chemical)	Total body water (TBW) Body fat (BF) Fat-free mass (FFM)	Participant compliance to strict testing prerequisites assumed – including abstaining from exercise Assumes geometric similarity between individuals Assumes tissue resistivity is similar between individuals Input data (age, height, weight, athletic status) accounts for high (up to 85%) of variance in the outcome variable.	Compared with multi-component models for young adults[108] FFM—SEE 2.5–3.9 BF—SEE 3.6 TBW—SEE 1.7–3.8	Intra-individual CV 2.0–3.5%[108] Prediction errors 3.0–8.0% for TBW 3.5–6.0% for FFM	Minimal participant involvement Non-invasive and no radiation Rapid data acquisition Precision good for TBW Apparent sophistication	Accuracy poor – most have used questionable criterion measures for comparison Lack of standardised protocols Results affected by hydration and electrolyte status No athlete-specific equations Trunk contributes only a small proportion to total impedance Different electrode placement (arm–leg, leg–leg, arm–arm) Large variability for outcome measures between devices
DXA (chemical)	Directly BMC Indirectly FM LBM	Interpolation for soft tissues in areas where bone is detected (40–45% of pixels affected)[92] Use standardised, best practice protocols [96] Awareness of misconceptions regarding which tissues comprise FM and LBM[98] Animal models used for human soft tissue calibration[98] Assumptions required and correction factors applied[104] when estimating soft tissue composition	Compared with multi-component models[105] %FM 2.0–3.0% SEE SM 1.6–4.4 kg SEE DXA calibration does not accommodate the physiques of lean athletes[101]	Scan-rescan analysis with repositioning[106] BMC 0.60% CV† FM 0.82% CV %FM 0.86% CV In 'athletic' populations[96] BMC 0.70% TEM FM 1.90% TEM LBM 0.40% TEM	Standardised protocols Data norms for BMD available Good precision for bone mineral Time efficient Small single scan radiation dose Whole-body approach Regional compartment analysis Provides estimate of whole body and regional FM, LBM and BMD	Not applicable to field work Inter-machine and inter-manufacturer variability Consideration of cumulative X-ray dose for multiple scans Cannot scan if pregnant Provides an indirect measure of LBM Calculation algorithms differ between manufacturers and are not published Pencil vs fan-beam outcomes differ Expensive equipment Restrictive exercise, fasting and hydration requirements prior to scanning (for athletes)



Adaptiert aus: Mathisen TF et al. BJSM. 2023.

15

SUM approach

Downloaded from http://bjsm.bmj.com/ on March 8, 2016 - Published by group.bmj.com

Original article

OPEN ACCESS

Subcutaneous fat patterning in athletes: selection of appropriate sites and standardisation of a novel ultrasound measurement technique: ad hoc working group on body composition, health and performance, under the auspices of the IOC Medical Commission

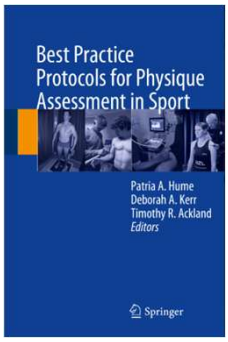
Wolfram Müller,[1] Timothy G Lohman,[2] Arthur D Stewart,[3] Ronald J Maughan,[4] Nanna L Meyer,[5] Luis B Sardinha,[6] Nuwanee Kirihennedige,[5] Alba Reguant-Closa,[5] Vanessa Risoul-Salas,[5] Jorunn Sundgot-Borgen,[7] Helmut Ahammer,[1] Friedrich Anderhuber,[8] Alfred Fürhapter-Rieger,[1] Philipp Kainz,[1] Wilfried Materna,[9]

Sports Medicine (2020) 50:597–614
https://doi.org/10.1007/s40279-019-01192-9

ORIGINAL RESEARCH ARTICLE

Relative Body Weight and Standardised Brightness-Mode Ultrasound Measurement of Subcutaneous Fat in Athletes: An International Multicentre Reliability Study, Under the Auspices of the IOC Medical Commission

Wolfram Müller[1] · Alfred Fürhapter-Rieger[1] · Helmut Ahammer[1] · Timothy G. Lohman[2] · Nanna L. Meyer[3] · Luis B. Sardinha[4] · Arthur D. Stewart[5] · Ronald J. Maughan[6] · Jorunn Sundgot-Borgen[7] · Tom Müller[1] · Margaret Harris[3] · Nuwanee Kirihennedige[3] · Joao P. Magalhaes[4] · Xavier Melo[4] · Wolfram Pirstinger[1] · Alba Reguant-Closa[3] · Vanessa Risoul-Salas[3] · Timothy R. Ackland[8]



SCIENTIFIC REPORTS

OPEN

Measurement of mean subcutaneous fat thickness: eight standardised ultrasound sites compared to 216 randomly selected sites

Received: 8 December 2017
Accepted: 4 October 2018
Published online: 02 November 2018

Paul Störchle[1], Wolfram Müller[1], Marietta Sengeis[1], Sonja Lackner[1], Sandra Holasek[1] & Alfred Fürhapter-Rieger[1]

Training & Testing

Thieme

Competitive Performance of Kenyan Runners Compared to their Relative Body Weight and Fat

Authors
Marietta Sengeis[1,2], Wolfram Müller[1], Paul Störchle[1], Alfred Fürhapter-Rieger[1]

Received: 8 May 2018 | Accepted: 24 June 2019
DOI: 10.1111/sms.13508

ORIGINAL ARTICLE

WILEY

Body weight and subcutaneous fat patterning in elite judokas

Marietta Sengeis[1,2] | Wolfram Müller[1] | Paul Störchle[1] | Alfred Führhapter-Rieger[1]

Review

OPEN ACCESS

Best practice recommendations for body composition considerations in sport to reduce health and performance risks: a critical review, original survey and expert opinion by a subgroup of the IOC consensus on Relative Energy Deficiency in Sport (REDs)

Therese Fostervold Mathisen,[1] Timothy Ackland,[2] Louise M Burke,[3] Naama Constantini,[4] Judith Haudum,[5] Lindsay S Macnaughton,[6] Nanna L Meyer,[7] Margo Mountjoy,[8,9] Gary Slater,[10] Jorunn Sundgot-Borgen[11]

16

ABLAUF DER MESSUNG

EINZEICHNUNG

All distances are percentages of body height (h)

MESSSTELLEN

UA	upper abdomen
LA	lower abdomen
FT	front thigh
LT	lateral thigh
MC	medial calf
ES	erector spinae
DT	distal triceps
BR	brachioradialis

BILDAUFNAHME

Alpinion ECUBEi7, L3-12T

*"**Ultrasound** measures of subcutaneous adipose tissue were **unaffected** by acute changes in **hydration status** by extents beyond which are rare and overtly self-correcting, suggesting that this method provides reliable and robust body composition results even when subjects are not euhydrated"*

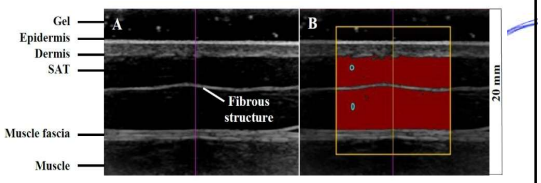
Wagner DR and Cotter JD. Int J Sport Nutrition and Exercise Metabolism, 2021

According to a standardised protocol:
Müller W et al. Br J Sports Med. 2016

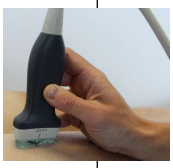
17

Von der Wissenschaft in die Sportpraxis

STANDARDISIERTE ULTRASCHALL METHODE: SUBKUTAN-FETTMESSUNG



Sengeis M. et al. Scand J Med Sci Sports. 2019



ACCURACY

0.1 mm at 18 MHz frequency
0.2 mm at 10 MHz frequency

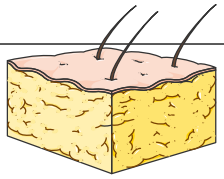
RELIABILITY

SAT THICKNESS measurements (8 sites, D_1); 95%-LOA:
< 1.5 mm
SAT MASS estimates (8 sites); 95%-LOA:
0.2 kg SAT mass

Müller W, et al. Br J Sports Med. 2016, Müller W, et al. Sports Med. 2020, Kelso A, et al. BMC Pediatrics. 2020, Störchle P, et al. Ultrasound Med Biol. 2017, Mathisen TF et al. Br J Sports Med 2023.

18

Adipose Tissue

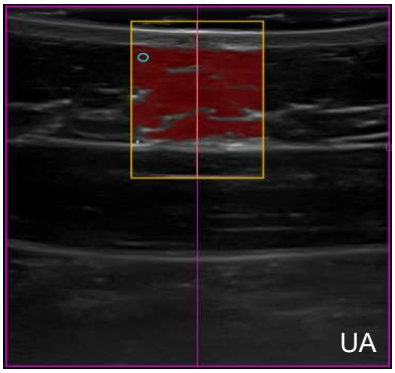


FAT TISSUE
smartservier.com

Adipocytes
smartservier.com

Adipose tissue has a fat-free or „lean“ component (1)

- Water ~15%
- Protein ~5%



Weihgt loss: adipose tissue mass is typically reduced -> loss of molecular level fat as well some degree of obligatory loss of the fat-free component of adipose tissue.

Adipose tissue measurement methods:
MRI, CT, US (local assessment) – Organ/Tissue Level

FAT MASS (FM): fat molecules (ie, nonpolar lipids, mainly triglycerides).

ADIPOSE TISSUE: fat molecules (~80%-85%), water (~15%) and protein (~5%) (1)

FAT FREE MASS (FFM): nonfat molecules in the body. Molecular categories (~74% water, protein (~19%), mineral (~6,5%), and Residual.

(1) Grant M. Tinsley and Steven B. Heymsfield. Journal of the Endocrine Society, 2024. Referenzdaten siehe auch: Snyder WS et al. Repot of the task group on reference man. Ann ICRP.1975;3(1-4):iii.

19

Ausgewählte Funktionen von Skelettmuskulatur, Fettgewebe und Knochen.

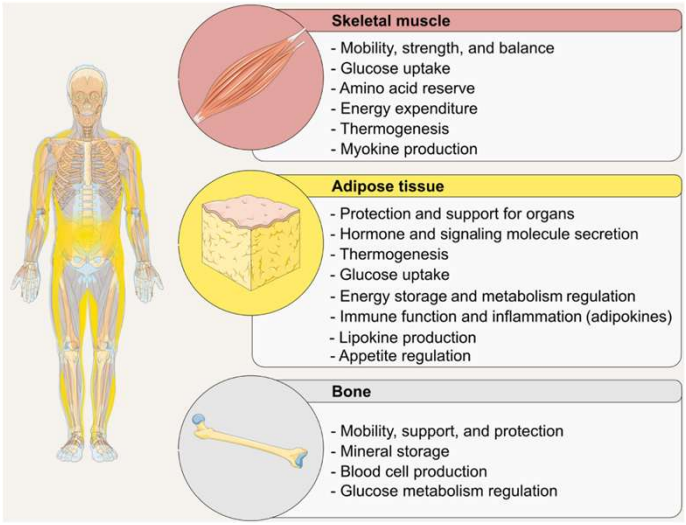


Abb.: Prado CM et al. Journal of the Endocrine Society, 2024, 8, bvae164.

20

5- LEVEL MODEL OF BODY COMPOSITION

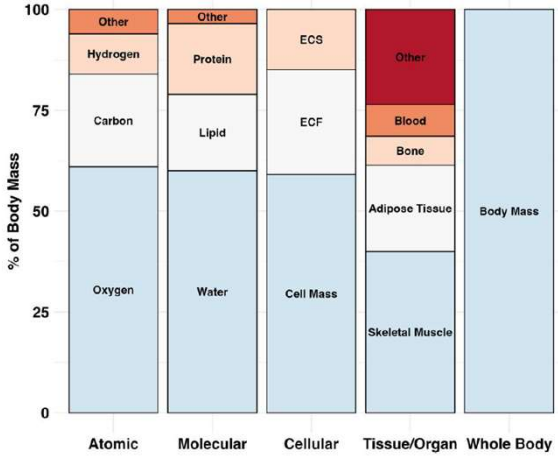


Abb.: Prado CM et al. Journal of the Endocrine Society, 2024, 8, bvae164.
Abk.: ECF, extracellular fluid; ECS, extracellular solids.

Komponenten der am häufigsten verwendete Modelle zur Bewertung der Körperzusammensetzung

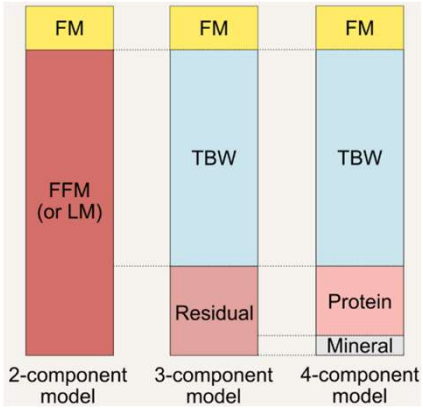
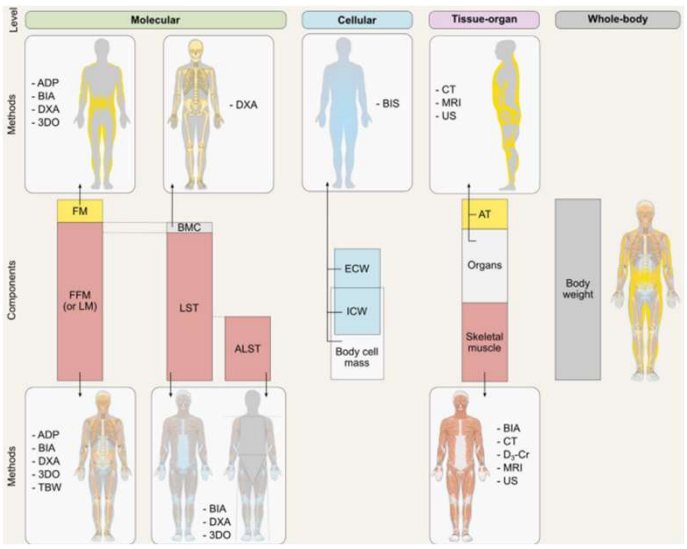


Abb.: Prado CM et al. Journal of the Endocrine Society, 2024, 8, bvae164.
Abk.: FFM, fat-free mass; FM, fat mass; LM, lean mass; TBW, total body water.

21

Bestandteile und Methoden

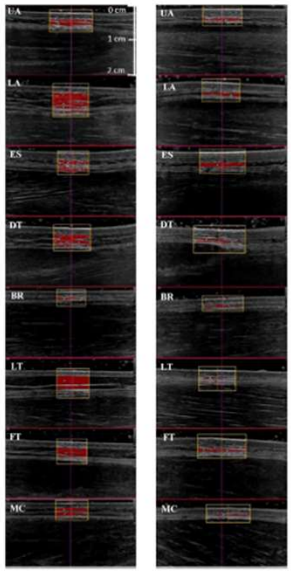


Prado CM et al. Journal of the Endocrine Society, 2024, 8, bvae164.

Abk.: 3DO, 3D optical; ADP, air displacement plethysmography; ALST, appendicular lean soft tissue; AT, adipose tissue; BIA, bioelectrical impedance analysis; BIS, bioimpedance spectroscopy; BMC, bone mineral content; CT, computerized tomography; D_3-Cr, D_3-creatine dilution; DXA, dual-energy X-ray absorptiometry; ECW, extracellular water; FFM, fat-free mass; FM, fat mass; ICW, intracellular water; LST, lean soft tissue; MRI, magnetic resonance imaging; TBW, total body water; US, ultrasound.

22

J1: J2:



Sengeis M. et al. SJMSS, 2019

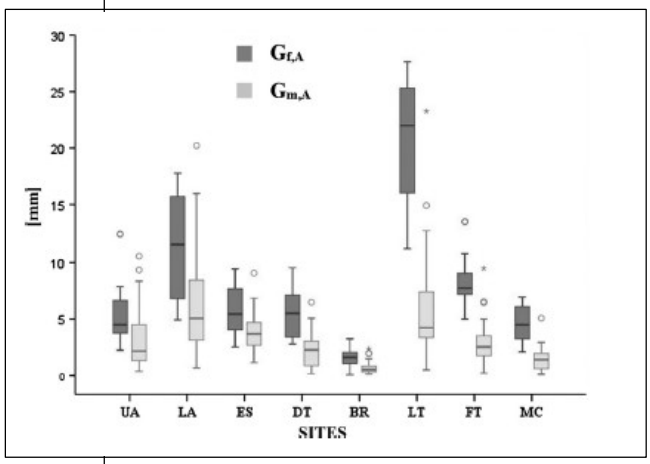
KALIPER VERSUS ULTRASCHALL

JUDO – Elite (J1,J2 männlich)

- Gleiche Summenwerte mittels Skinfolds (S): **45.4 mm**, aber beträchtliche Unterschiede bei Anwendung der Ultraschalltechnik (US)
- J1: **20 mm** und J2: **5.1 mm**
- Gleiche Summenwerte mittels S unterscheiden sich um einen Faktor 4 bei Verwendung von US

J1: WC 66 kg, 66.2 kg, 1.751 m, BMI 21.6 kgm^{-2}
J2: WC 81 kg, 84 kg, 1.824 m, BMI 25.2 kgm^{-2}
WC=weight category

23



Sengeis M. et al. SJMSS, 2019

FETTVERTEILUNGSMUSTER FRAUEN und MÄNNER

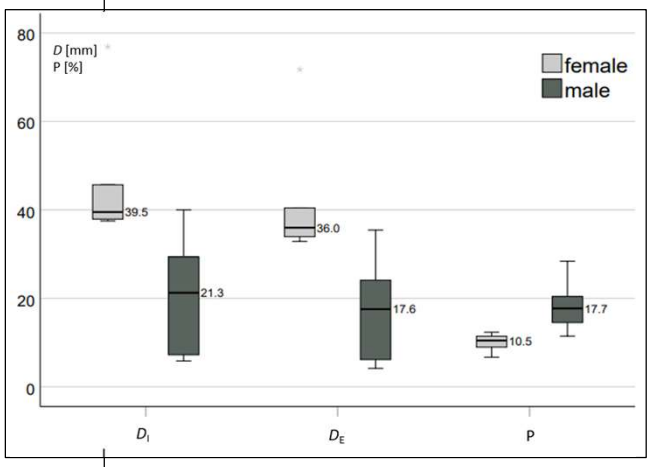
- An allen acht standardisiert gemessenen Körperstellen (Judo) haben Frauen signifikant höhere Werte
- Größter Ratio befindet sich an der Stelle äußerer Oberschenkel
- Ähnliche Fettverteilungsmuster in anderen Sportarten

siehe Kelso A. et al. European Journal of Sport Science, 2017; Sengeis M. et al. Int J Sports Med, 2020.

Abk.: UA upper abdomen, LA lower abdomen, ES erector spinae, DT distal triceps, BR brachioradialis, LT lateral thigh, FT front thigh, MC medial calf

24

GRUPPENANALYSE von INTERNATIONAL WETTKÄMPFENDEN TRIATHLET:INNEN



- SAT thickness sums in terms of D_I differed significantly (Z=-2.963, p<0.001) between elite female and male triathletes; D_I about 1.9 times higher in females
- f: $D_{I,MEDIAN}$: 39.5 mm, $D_{I,MIN-MAX}$: 37.5-76.9 mm
- m: $D_{I,MEDIAN}$: 21.3 mm, $D_{I,MIN-MAX}$: 5.9-40.0 mm
- six of 14 males had 'extremely low' D_I values
  (according to a preliminary assessment schedule: Ackland et al. 2018)

Sengeis M et al. XVII ISAK World Conference, 2022

females (f): age 24.0 ± 3.9 y, body height 1.68 ± 0.07 m, body mass 55.2 ± 3.6 kg, BMI 19.7 ± 1.2 kgm^{-2}, n= 5.
males (m): age 23.1 ± 4.4 y, body height 1.83 ± 0.05 m, body mass 72.9 ± 4.4 kg, BMI 21.7 ± 0.8 kgm^{-2}, n= 14.

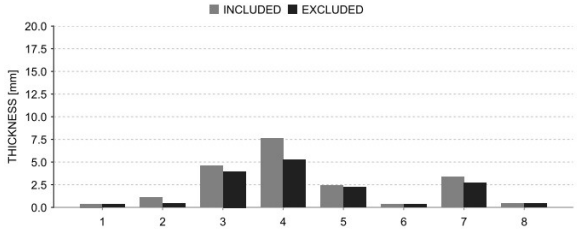
25

FALLBEISPIEL 1:

>25 Trainingsstunden/Woche

PRE

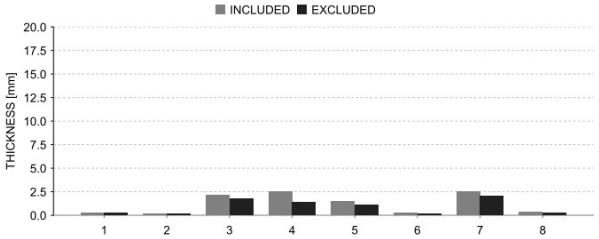
BMI: 16.5 kgm^{-2}
MI_1: 16.7 kgm^{-2}
SAT 8 (D_I): 20.3 mm, SATmass: 2.9 kg



3 Monate später

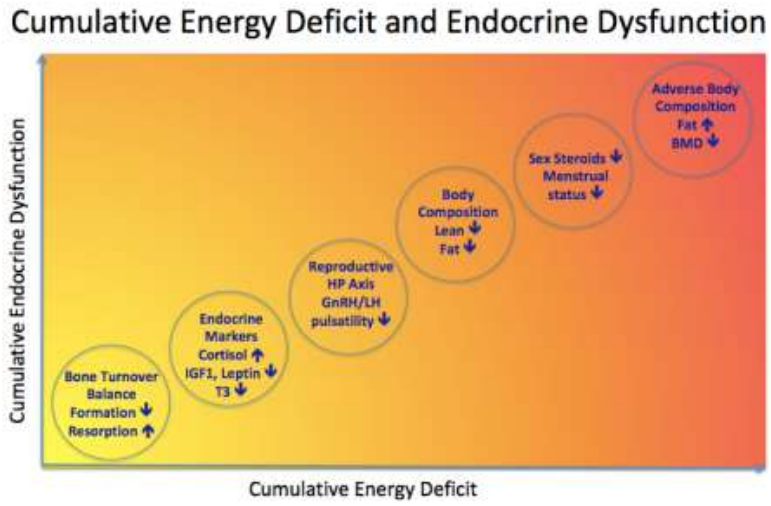
POST

BMI: 16.1 kgm^{-2}
MI_1: 16.3 kgm^{-2}
SAT 8 (D_I): 9.5 mm, SATmass: 1.6 kg



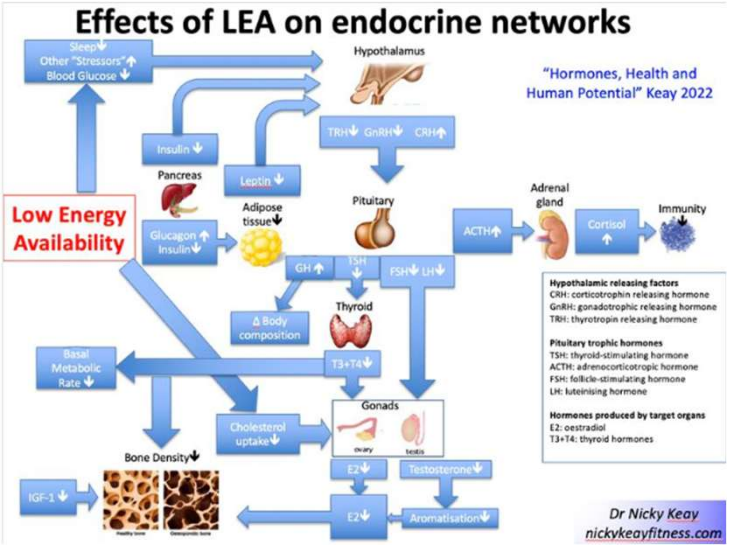
LEISTUNG und GESUNDHEIT ???

26



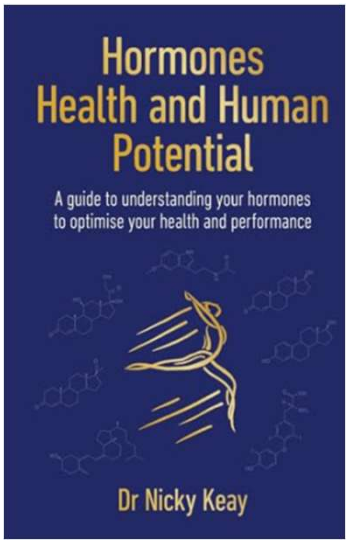
Keay N, Rankin A. Infographic. Relative energy deficiency in sport: an infographic guide. BJSM 2019:53:1307-1309

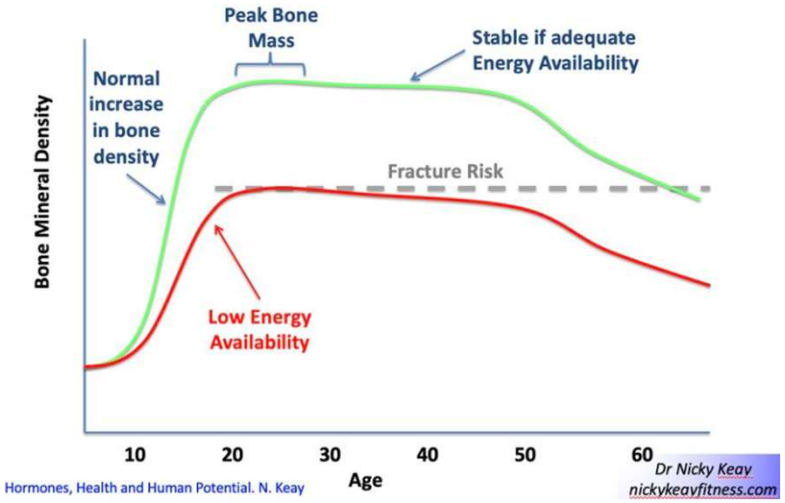
27



https://nickykeayfitness.com/2017/01/17/optimal-health-for-all-athletes-part-4-mechanisms/

28



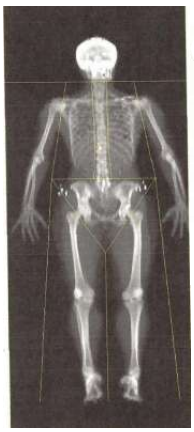


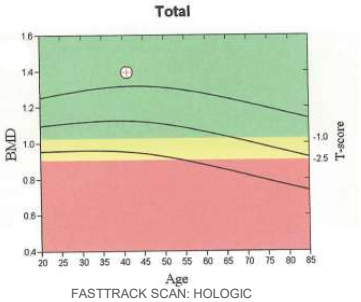
https://www.linkedin.com/posts/nickykeay_nutrition-hormones-bone-activity-7186988710402347009-RSta

Bildquelle: Keay N. Homone Health and Human Potential2022, S. 122.

29

"langfristige" KNOCHENGESUNDHEIT

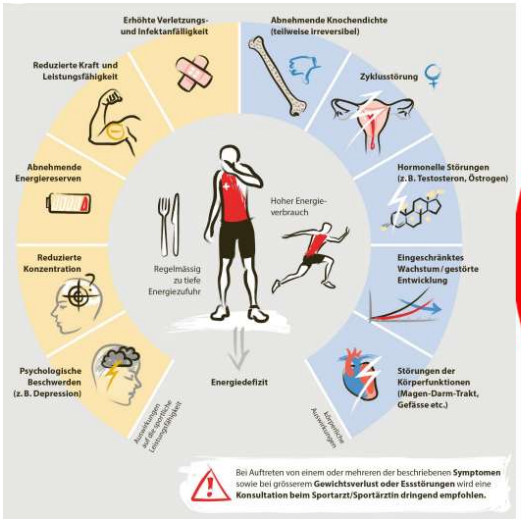


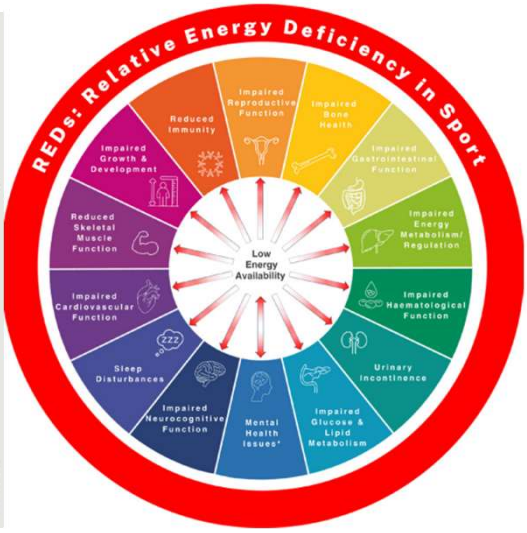


According to IADMS; Resource paper for dancers and teachers. Robson B, Chertoff A. Bone Health and female dancers. 2018.:

- ✓ *...."promoting healthy attitudes towards body physique;*
- ✓ *informing dancers of the relationship between energy intake and energy availability;*
- ✓ *promotion adequate nutrition and other factors benefiting bone health,*
- ✓ *being aware of early signs of problems with the spectrum of eating behavior, menstrual health and bone health;*
- ✓ *referring at-risk dancers to appropriate help;*
- ✓ *supporting regular medical checkups to track hormone function and the menstrual cycle;*
- ✓ *developing guidelines to support optimal health and well-being of each dancer".*

30





Matter S, Flück J. Wie wirkt sich ein relative Energiemangel (RED-S) auf Körper und Leistungsfähigkeit aus? https://www.swissolympic.ch/dam/jcr:4b4f2689-8cca-4489-bf36-75e399d0b8f6/SwissOlympic-FS_SS+F_RED-S-de.pdf (Zugriff am: 22.09.25)

Mountjoy M, Ackerman KE, Bailey DM, et al. Br J Sports Med 2024;57:1073–1098

31

REDs

- Hoher Energieverbrauch in Verbindung mit hohem Trainingsvolumen u/o hoher Trainingsintensität erhöht das Risiko (Entwicklung REDs)
- Tänzer:innen/Sportler:innen, die sich noch im Wachstum befinden und gleichzeitig ein hohes Trainingsvolumen haben, haben einen zusätzlichen Bedarf für die ideale Nährstoffzufuhr (Wasserfurth, 2020)

  (Young athletes are particularly vulnerable to developing REDs during a period of growth and development accompanied by a high training load (Keay, 2017))
- Die Behandlung (Treatment) von REDs umfasst einen multidisziplinären Ansatz mit dem Ziel, einer idealen Abstimmung des Energiebedarfs mit dem Energieverbrauch (Dave, S. C., 2022)
- Zusätzlich zu den Ernährungsmodifikationen ist eine Beendigung oder Verringerung des Trainingsvolumens, der Trainingsintensität u/o des Trainings erforderlich, um die Energiezufuhr rechtzeitig wiederherzustellen (National Eating Disorder Association)

Wasserfurth, Paulina, et al. Sports medicine-open, 2020, 6. Jg., Nr. 1, S. 44.
Dave, S. C., & Fisher, M. (2022). Relative energy deficiency in sport (RED–S). Current problems in pediatric and adolescent health care, 52(8), 101242.
Keay N. Young athletes' optimal health: Part 3 Consequences of Relative Energy Deficiency in sports. BMJ, 2017

32

FALLBEISPIEL 2: Ästhetic Sport

Individueller Wunsch: Gewichtsreduktion

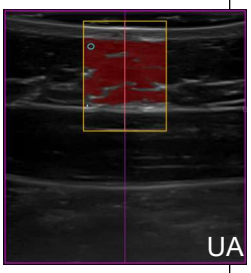
20 Trainingsstunden/Woche

Nährstoffauswahl, Timing

Meal	What did you eat? Did you take supplements and which? Did you buy your food or prepare it yourself?	How much? (Gram, tablespoon, hand size...)	What did you drink?	How much? (litre, ml)
Breakfast Time:	2 eggs with vegetables 7.a.m	2 eggs 300g veg.	Black coffee	150ml
Snack Time:			water	
Lunch Time:	Steamed white meat with vegetables 1.p.m.	140g meat Lots of veg.	water	
Snack Time:	Ice tea zero at school (4.p.m.)			500ml
Dinner Time:	Salad with egg 6.p.m.	1 egg Lots of veg.	water	
Snack Time:			Green tea	250ml

Auswirkungen auf die Körperzusammensetzung

BMI: 19.7 kgm^{-2}
MI_1: 20.1 kgm^{-2}
Sum 8 (D_I): **84.1 mm**
SATmass: 8.0 kg

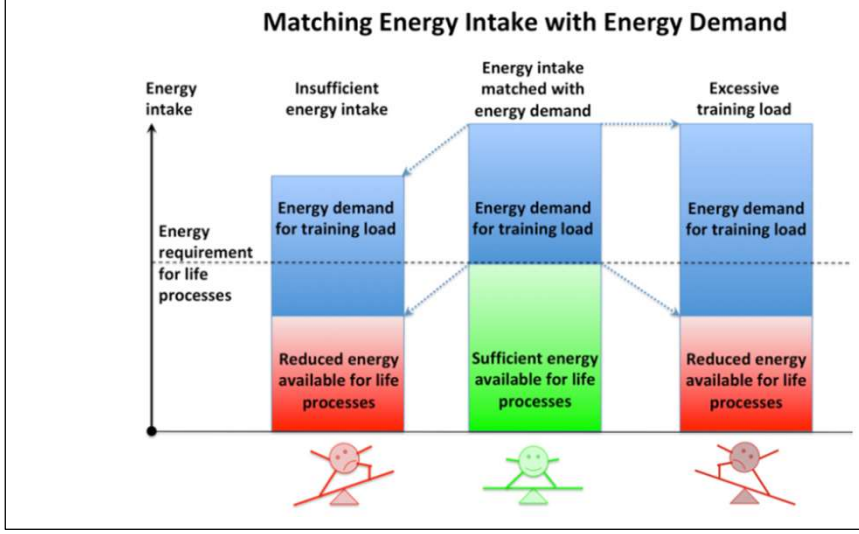


33

"Within-day energy deficiency (WDED) has prieviously been associated with an unfavorable body composition in female elite gymnasts and runners, presumably related to both an adaptive reduction in RMR, and endocrine responses that favour muscle catabolism and fat gain. Therefore, a restrictive eating behavior, resulting in more hours spent in energy deficiency, may have the opposite of the desired effect on athletes ' body composition".

Fahrenholtz IL. et al. Scan J Med Science in Sports, 2017.

34

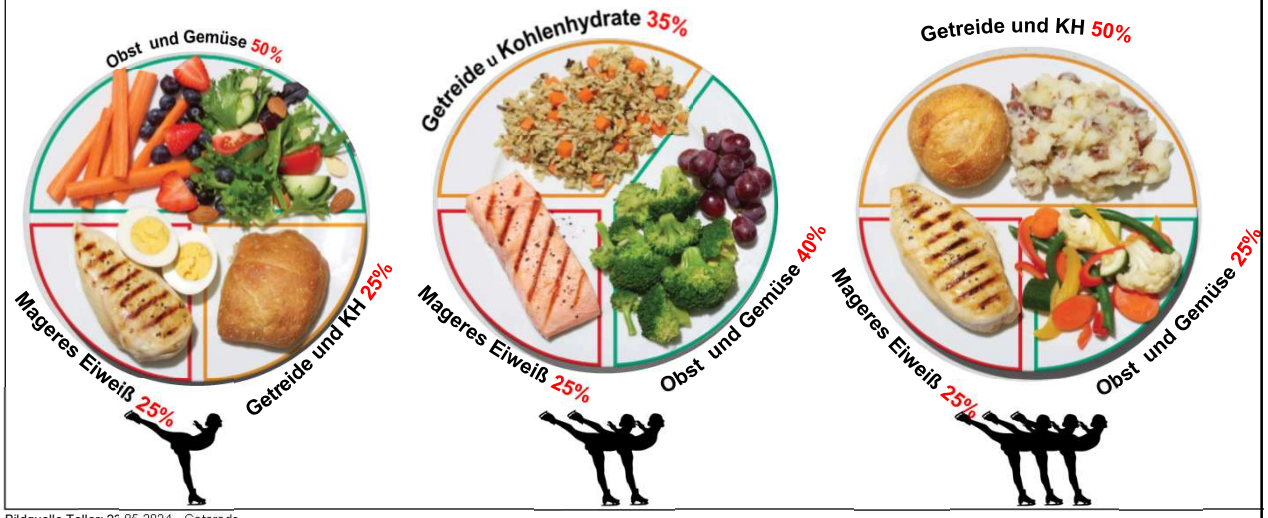


Bildquelle: https://blogs.bmj.com/bjsm/2018/10/30/raising-awareness-of-red-s-in-male-and-female-athletes-and-dancers/ (Zugriff:22.09.2025)

35

Education - TOOLS

"Mehr Leistung benötigt mehr Energie und Nährstoffe"



Bildquelle Teller: 23.05.2024_ Gatorade

36

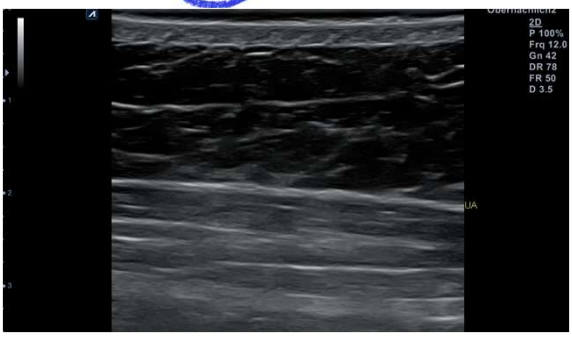
FALLBEISPIEL 3: Freizeit-Gesundheitssport

>2-3 Trainingsstunden/Woche (aktiven Lebensstil positiv verändert)

BMI: 32.6 kgm^{-2}
W/h: 0.58
SAT 8 (D_l): 104.6 mm
d_{UA}: 19.3 mm

PRE → 8 Monate später → POST

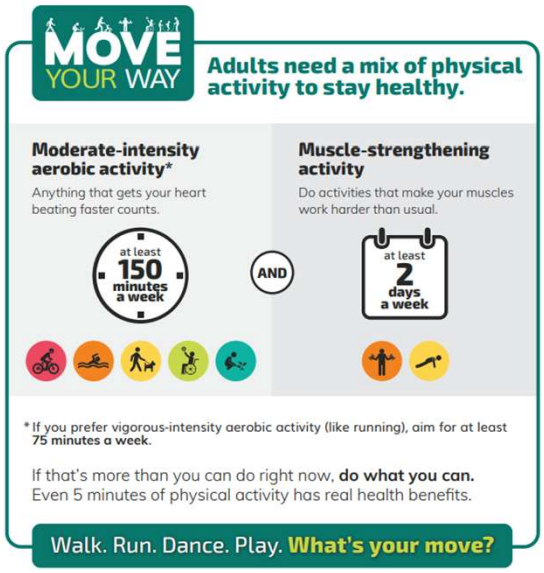
BMI: 28.4 kgm^{-2}
W/h: 0.50
SAT 8 (D_l): 71.9 mm
d_{UA}: 14.2 mm

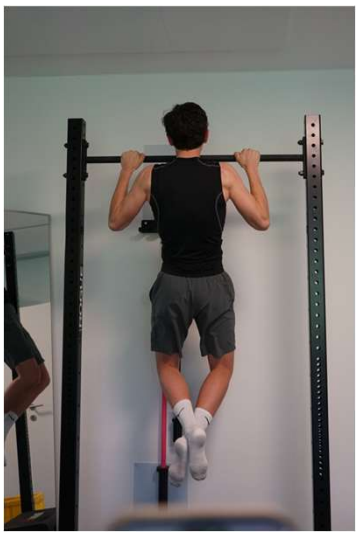


⇄ LEISTUNG und GESUNDHEIT ???

37

PHYSICAL ACTIVITY - WORKS

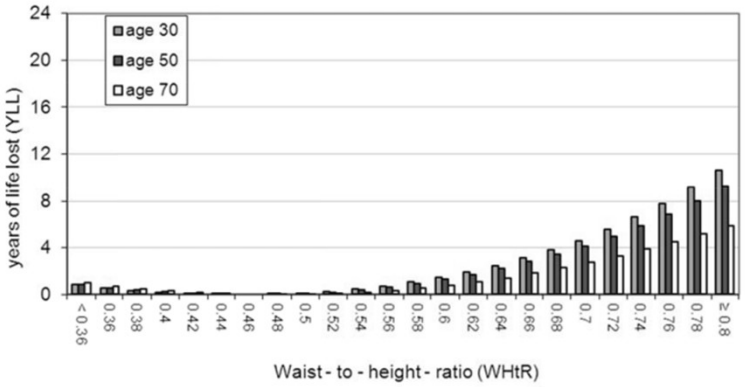




Physical Activity Guidelines for Americans. 2nd Edition. 2018

38

Waist to Height Ratio (WHtR)



YLL relative to WHtR 0.46 in female non-smokers. Optimal: 0.46 ("ok" range of WHtR 0.4 to 0.5- minimal increased mortality risk)
"Consider Action: 0.5-0.6; YLL increases markedly after WHtR 0.6 (doi:10.1371/journal.pone.0103483.g006)

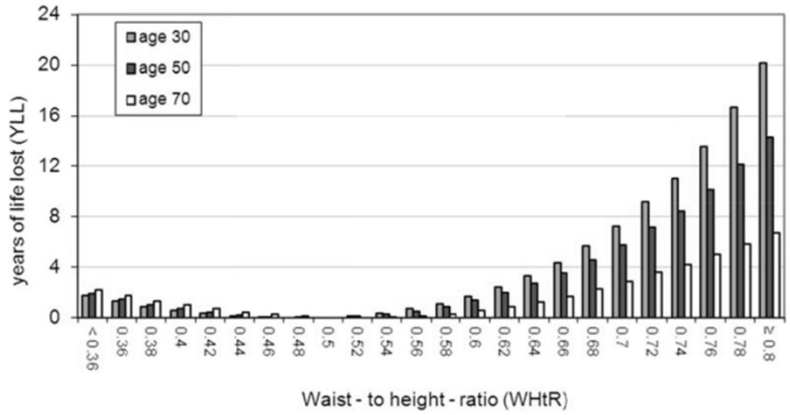
Ashwell M. et al., PloS ONE. 2014

39

Waist to Height Ratio (WHtR)

F3:PRE
W/h: 0.58

F3:POST
W/h: 0.50



YLL relative to WHtR 0.46 in male non-smokers. Optimal: 0.46 ("ok" range of WHtR 0.4 to 0.5- minimal increased mortality risk)
"Consider Action: 0.5-0.6; YLL increases markedly after WHtR 0.6 (doi:10.1371/journal.pone.0103483.g006)

Ashwell M. et al., PloS ONE. 2014; F3: Fallbeispiel 3

40

Sportanthropometrie im Hochleistungssport

relatives Körpergewicht, Subktutanfett, Muskulatur, Proportionen, Körperzusammensetzung

- Information „INTERDISZIPLINÄR“ nützen
- Medizin (Sportmedizin)
- Ernährung
- Physiotherapie
- Sportwissenschaft
- Athletiktraining (Umsetzung)
- Psychologie
- Pädagogik (Education)
- Umfeld

41

PRAXIS:

- ❑ Genaue und verlässliche Methoden zur Vermessung der Körperzusammensetzung essenziell
- ❑ Sorgfältige Interpretation und Kommunikation der Ergebnisse
- ❑ Health / Performance Team (interdisziplinär)
- ❑ Bei Intervention: Kommunikation der Follow-Up Termine und Absprache mit Team/Coach/Athlet
- ❑ Optimierung der Körperzusammensetzung unter professioneller Aufsicht (nach Plan)

Siehe auch: Best practice recommendations for body composition considerations in sport to reduce health and performance risks: a critical review, original survey and expert opinion by a subgroup of the IOC consensus on Relative Energy Deficiency in Sport (REDs) Br J Sports Med. 2023.

42

LEISTUNGSSPORT AUSTRIA

DISKUSSION & AUSTAUSCH

43

LEISTUNGSSPORT AUSTRIA

Mag.ª Dr.in
MARIETTA SENGEIS
m.sengeis@leistungssport.at

44