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Joint Hypermobility – Effect of a Resistance Training Program on Disability and Function

Gerhard «Gere» Luder, PT MSc cand. PhD

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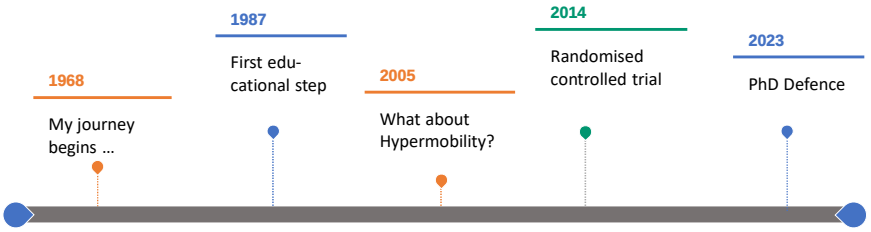
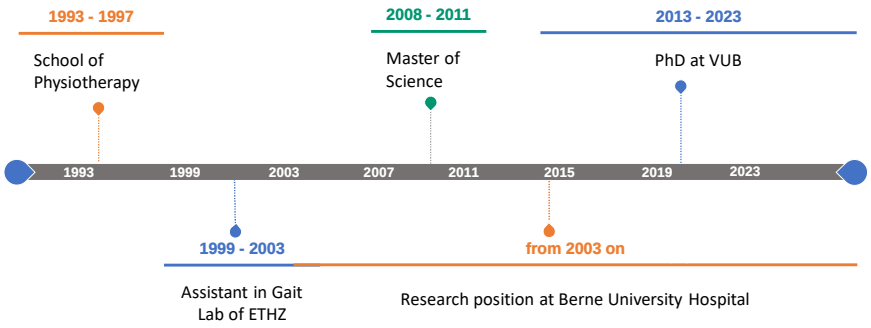
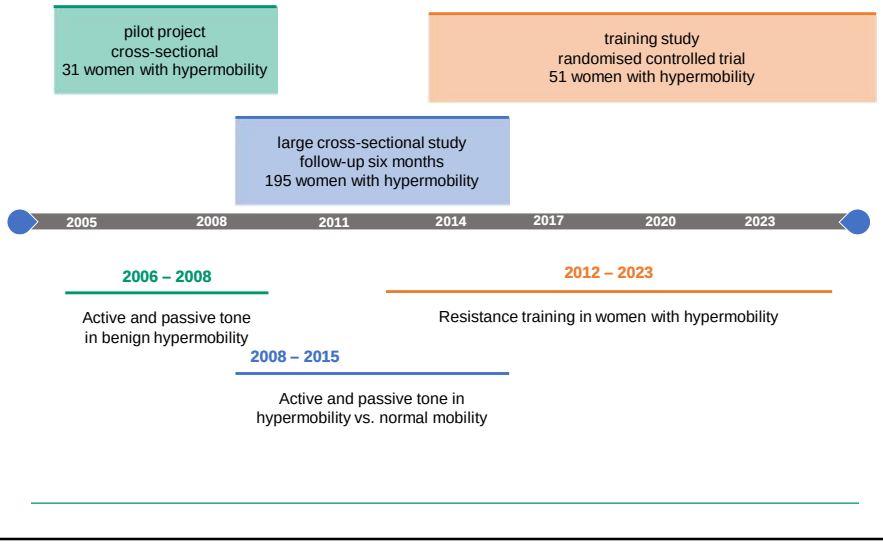
Joint Hypermobility – a scientific, clinical and personal journey …



My personal journey to the PhD…



Joint Hypermobility – the Projects



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Joint Hypermobility – the Projects

pilot project
cross-sectional
31 women with hypermobility

training study
randomised controlled trial
51 women with hypermobility

large cross-sectional study
follow-up six months
195 women with hypermobility

2005 2008 2011 2014 2017 2020 2023

Biomechanical questions
- What is normal?
- How to measure?

Clinical questions
- Symptoms
- Disability

Clinical management
- Effect
- Feasibility

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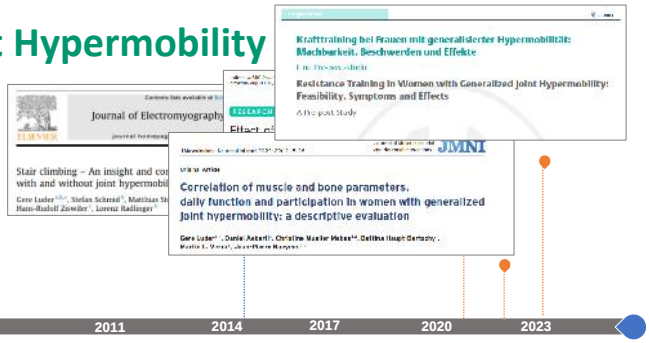
Joint Hypermobility



2005 2011 2014 2017 2020 2023

2006 – 2008

pilot project
cross-sectional
31 women with hypermobility

2012 – 2023

training study
randomised controlled trial
51 women with hypermobility

2008 – 2015

large cross-sectional study
follow-up six months
195 women with hypermobility

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Chapter 1. Background & Introduction

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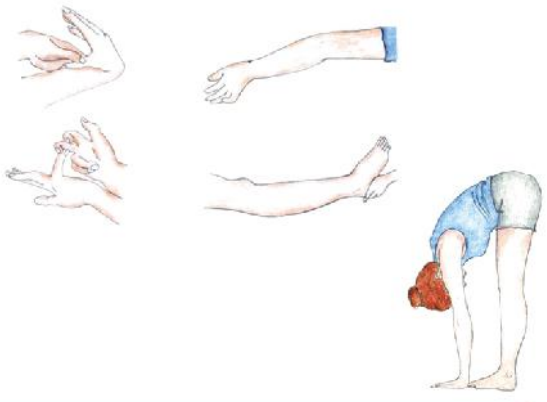
Definition of Joint Hypermobility?

- Higher range of motion in one or several joints…
- Generalized Joint Hypermobility defined by Beighton Score
  - Little finger
  - Thumb
  - Extension of elbow
  - Extension of knee
  - Touch floor with palm of hands
- Various cut-offs
  - Originally ≥ 4/9
  - Age-dependent
    - till 20 years ≥ 6/9
    - 20-50 years ≥ 5/9
    - over 50 years ≥ 4/9



Beighton 1973; Remvig 2007; Singh 2017; Juul-Kristensen 2017

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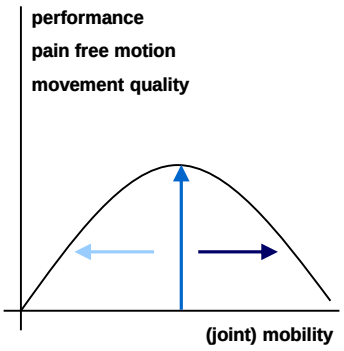
How much mobility is “normal” or “optimal”?

- **Optimal mobility**
  Movement is well controlled and pain-free
- **Mobility too low**
  → limited mobility
  → well known in PT
  → many techniques for “mobilisation”
- **Mobility too high**
  → hypermobility
  → little knowledge about implications
  → no therapy to reduce mobility



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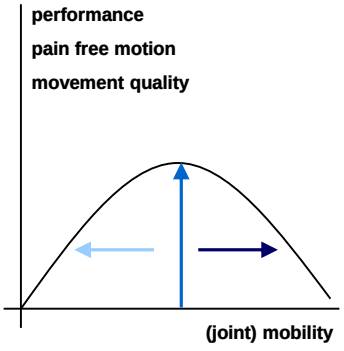
How much mobility is “normal” or “optimal”?

- Maybe different for various joints
- Depending on age
  - Decrease is normal
- Depending on sex
  - Women with higher mobility
- Depending on sports and daily life activities



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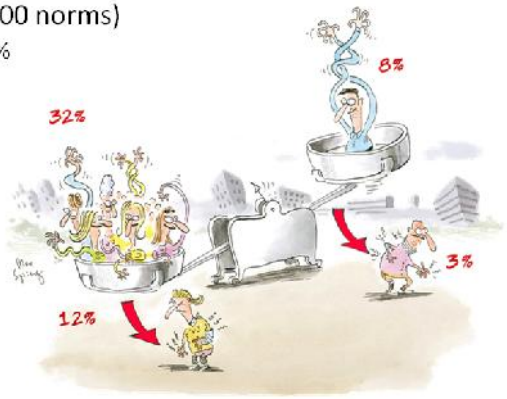
Prevalence of "Hypermobility"

- Wide range of reported numbers
- Depending on population, definition and cut-off
- Large Australian cohort (1000 norms)
  - 20-39 y: women 10%, men 4%
- Other studies (women)
  - USA 32%
  - Brazil 28%
  - Netherlands 32%



Singh 2017; Russek 2016; Antonio 2018; Noormohammadpour 2019; Scheper 2015

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Joint Hypermobility – Advantage, Problem, or Disease?

- A long and ongoing debate …
- Advantage for some sports, for dancers, for musicians
- Risk for injury or overuse
- Stabilisation of joints
  - Passive structures
  - Active stabilisation
  - Muscles and neural control
- Systemic complaints (skin, vessels, digestion, …)

Grahame 1972; Smith 1967; Baeza-Velasco 2013; Nicholson 2022; Baban 2018; Jacobs 2014; Malfait 2020

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Joint Hypermobility – a typical journey…

child | adolescent | young person | middle-aged person | older person

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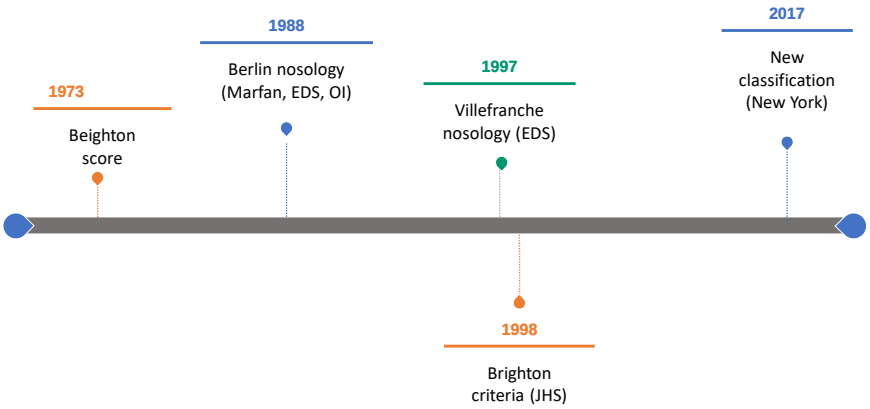
Diagnostic Labels in Joint Hypermobility



Beighton 1973; Beighton 1988; Beighton 1998; Grahame 2000; Malfait 2017; Castori 2017

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Joint Hypermobility Syndrome (JHS)

Defined by Brighton criteria (1998)

- Major criteria
  - Beighton score 4/9 or higher (currently or historical)
  - Arthralgia longer than 3 months in 4 or more joints
- Minor criteria
  - Beighton score 1, or 3
  - Arthralgia in 1-3 joints, back pain
  - Dislocation/ subluxation in more than one joint, or in one joint recurrent
  - Soft tissue rheumatism (epicondylitis, tenosynovitis, bursitis)
  - Marfanoid habitus (tall, slim, long thin fingers)
  - Abnormal skin: striae, hyperextensibility, thin skin
  - Varicose veins, hernia, uterine or rectal prolapse
- Fulfilled when: Two major / one major and two minor / four minor

Grahame 2000 ; Remvig et al. (2007) J Rheumatology 34:798-803

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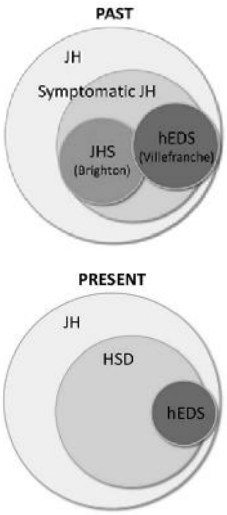
New Classification 2017 (New York)

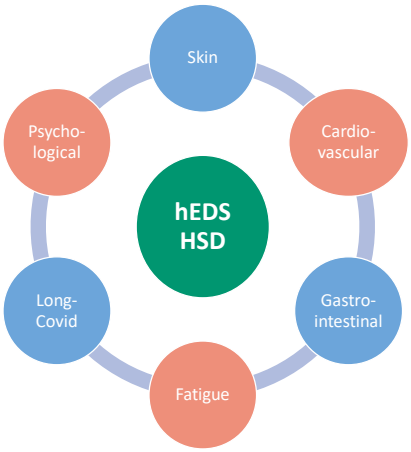
- Ehlers-Danlos Syndrome
  - 13 distinct types
  - 12 with genetic mutations
  - hypermobile EDS without gene marker
- Hypermobile EDS
  - Generalized Joint Hypermobility
  - Systemic features
  - Positive familial history
  - Musculoskeletal symptoms
  - Exclusion of other explanations
- Hypermobility Spectrum Disorder
  - No clearly defined criteria
  - Those, who have not hEDS …



Malfait 2017; Castori 2017; Tinkle 2017; Baban 2018 (figure)

Associated Disorders and Syndromes

- Wide range of symptoms and syndromes
- Association often remains unclear
- Many different systems involved



Gensemer 2021; Castori 2012; Eccles 2021

Consequences of Joint Hypermobility

- Similarly difficult as associated syndromes
- «Chicken-and-egg» problem
- Various impairments described
  - Lower strength
  - Alterations in gait
  - Reduced balance
- Long term consequences
  - Musculoskeletal injuries
  - Development of chronic pain
  - Deconditioning
  - Kinesiophobia

Scheper 2015; To 2019; Schmid 2013; Smith 2013; Mebes 2008; Tobias 2013; Junge 2019; Flowers 2018;

Management of Joint Hypermobility

- Not every person with GJH needs treatment
- Management of acute problems
  - Similar as others
  - Mainly symptom based
  - More patient education
- Lifelong management
  - Prevention and training
  - Avoiding overload and increase performance
  - Support self-management

Simmonds 2022; Palomo-Toucedo 2020; Clark 2017; Knight 2015;

Evidence for Physiotherapy

- Systematic review [Palmer 2021]
  - Eight randomised trials and three longitudinal studies
  - Weak study quality
- Exercise trials
  - Various types: inspiratory muscles, lumbar spine stabilization, proprioceptive exercise, heavy shoulder strengthening
  - Small and heterogenous groups
  - Inconsistent results
- Publication date
  - till 2012 3 trials
  - 2013-2018 4 trials
  - 2019-2021 4 trials

Palmer 2021; Daman 2019; To & Alexander 2019; Reychler 2019; Toprak-Celenay 2017; Liaghat 2020; Sahin 2008; Ferrell 2004

Resistance Training in Physiotherapy

- Widely used in physiotherapy
  - Using body weights, elastic bands, weight or machines
  - Aiming to increase muscle strength and function
- Positive effects in …
  - Elderly persons: improved strength and function
  - Fibromyalgia: improved strength, function and reduced pain
  - Knee osteoarthritis: improved pain and physical function
- Also recommended for healthy and athletes

Westcott 2012; Taylor 2005; Liu 2009; Busch 2014; Wewege 2018; Jansen 2011

Resistance Training & Joint Hypermobility

- Muscle weakness is an issue
  -> Improvements in strength important.
- Altered motor control and reduced proprioception
  -> Strengthening to improve proprioception and stability.
- Increase in strength
  -> body awareness and self-efficacy.

To 2019; Palomo-Toucedo 2020; Reychler 2019; Ferrell 2004; Moller 2014; Magnusson 2001; Liu 2009; Legerlotz 2020

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Chapter 2. Aims

- Is resistance training feasible and safe for women with joint hypermobility?
- Can women with joint hypermobility increase strength and muscle mass by a 12-week resistance training program?
- Does the 12-week resistance training have any influence on daily activities such as stair climbing and disability in daily life?

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Clinical Excursion …

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GERE LUDER
HOLLIGERHOF 8
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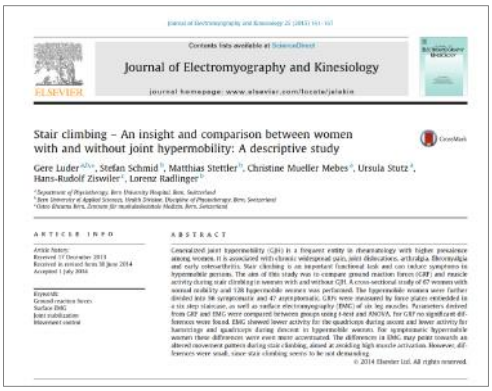
Chapter 3. Stair Climbing & Hypermobility



Journal of Electromyography and Kinesiology

journal homepage: www.elsevier.com/locate/jelekin

Stair climbing – An insight and comparison between women with and without joint hypermobility: A descriptive study

Gere Luder [a,b,*], Stefan Schmid [b], Matthias Stettler [b], Christine Mueller Mebes [a], Ursula Stutz [a], Hans-Rudolf Ziswiler [c], Lorenz Radlinger [b]

Generalized joint hypermobility (GJH) is a frequent entity in rheumatology with higher prevalence among women. It is associated with chronic widespread pain, joint dislocations, arthralgia fibromyalgia and early osteoarthritis. Stair climbing is an important functional task and can induce symptoms in hypermobile persons. The aim of this study was to compare ground reaction forces (GRF) and muscle activity during stair climbing in women with and without GJH. A cross-sectional study of 67 women with normal mobility and 126 hypermobile women was performed. The hypermobile women were further divided into 56 symptomatic and 47 asymptomatic. GRFs were measured by force plates embedded in a six step staircase, as well as surface electromyography (EMG) of six leg muscles. Parameters derived from GRF and EMG were compared between groups using t-test and ANOVA. For GRF no significant differences were found. EMG showed lower activity for the quadriceps during ascent and lower activity for hamstrings and quadriceps during descent in hypermobile women. For symptomatic hypermobile women these differences were even more accentuated. The differences in EMG may point towards an altered movement pattern during stair climbing, aimed at avoiding high muscle activation. However, differences were small, since stair climbing seems to be not demanding.

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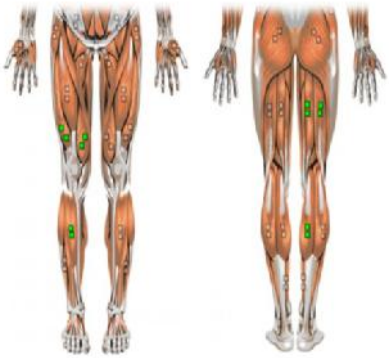
Cross-sectional Study: Stair climbing



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Participants

Inclusion

- Women
- Age 18 - 40 years
- Beighton-Score
  - Hypermobile group≥6/9
  - Normomobile group≤1/9

Exclusion

- Acute pain or trauma / surgery of the lower limbs and back during the last two years
- Pregnancy

normal mobility (NM)	hypermobile asymptomatic (HM-as)	hypermobile symptomatic (HM-s)
(n = 67)	(n = 47)	(n = 56)

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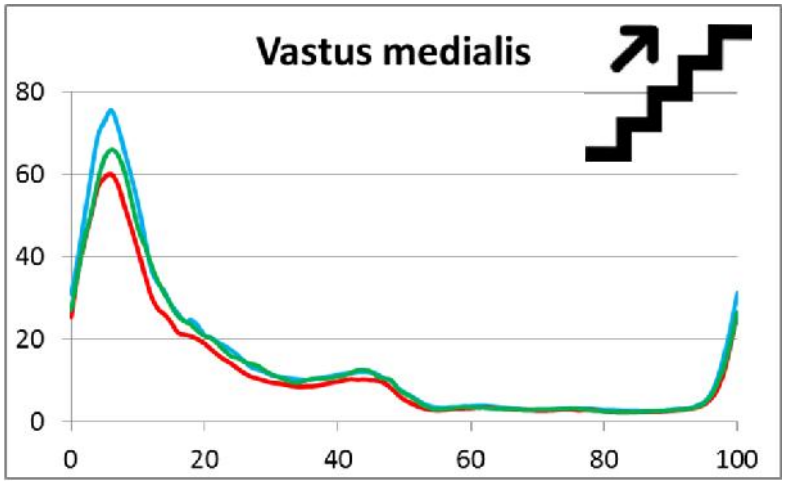
Mean Activity of anterior thigh [% maximum]



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Conclusion

- Altered muscle activity in hypermobile women
- More cautious movement pattern
  - Avoiding high forces by muscle activity
  - Avoiding pain
- But: Differences were small
  - Stair climbing might be a not enough demanding

Stacoff 2005; Larsen 2008; Palmieri-Smith 2013

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Chapter 4. Effects of Resistance Training

BMC Sports Science, Medicine and Rehabilitation

RESEARCH ARTICLE Open Access

Effect of resistance training on muscle properties and function in women with generalized joint hypermobility: a single-blind pragmatic randomized controlled trial

BMC

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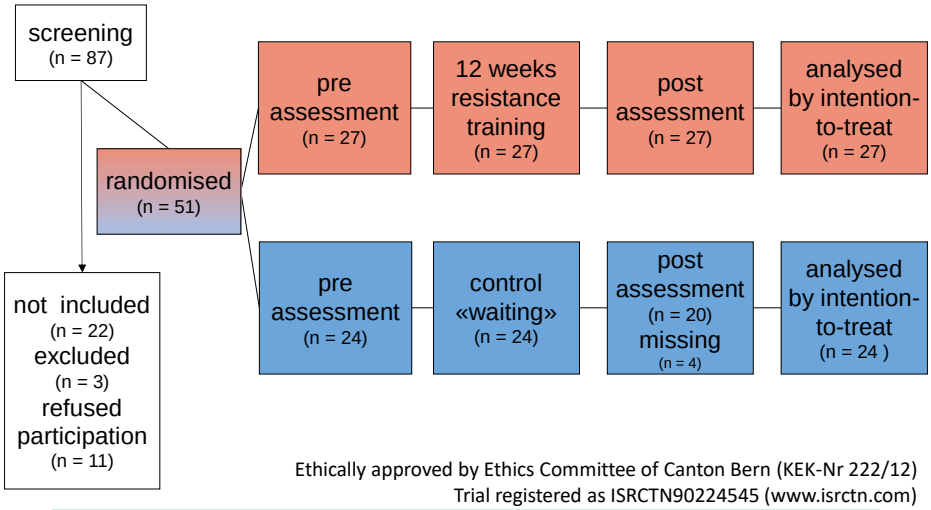
Study design: pragmatic randomised controlled trial



Ethically approved by Ethics Committee of Canton Bern (KEK-Nr 222/12)
Trial registered as ISRCTN90224545 (www.isrctn.com)

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Method: Resistance training

- Resistance at 80% of maximum, 12 repetitions, 3 sets
- 2 trainings per week, 50 min each, for 12 weeks → 24 sessions
- Three instruction session at begin and in week 3 and 6

Method: Assessments

- Tibial translation
- Knee strength
- Stair climbing
- Muscle cross-sectional area
- Questionnaires




Results: Changes by Training

→ Percentage change

		control (n=24)		training (n=27)	
		mean	95%CI	mean	95%CI
Muscle cross-sectional area of thigh	**mm²**	**46**	**+ 0.6%**	**194**	**+ 2.4%**
Knee extensor strength	N	8.3	- 9.4 to 26.1	6.3	- 16.5 to 29.1
Knee flexion strength	N	16.1	- 2.0 to 34.2	8.0	- 15.7 to 31.7

change post vs. pre per group / positive values = increase by training respective waiting

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Discussion: Possible Reasons

- No (measurable) strength gain due to …
  - Dynamic training
  - Static measurement

- Training intensity too low …
  - Insufficient increase of weight
  - Motivation, fear of pain
  - Maybe more coaching necessary!

- **However: resistance training might be an option!**

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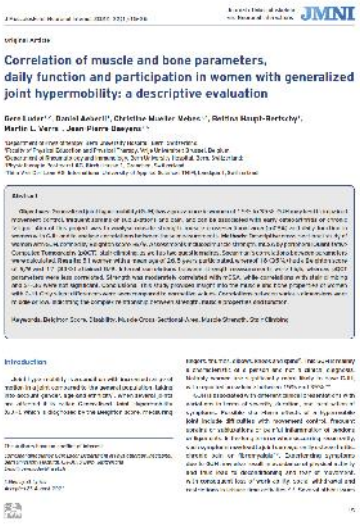
Chapter 5. Correlation of Muscle & Bone Parameters

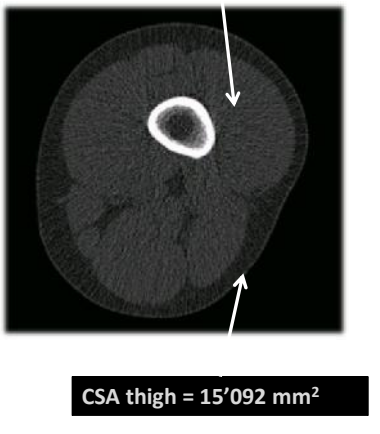


JMNI

Correlation of muscle and bone parameters, daily function and participation in women with generalized joint hypermobility: a descriptive evaluation

Method: Assessments

- Maximal muscle strength
  - Knee flexors und extensors
- Muscle cross-sectional area
  - By peripheral quantitative computer tomography (pQCT)



Participants and subgrouping

- Brighton criteria checked
  - Anamnestic
  - Measurements
- Subgrouping into
  - Generalized Joint Hypermobility (GJH)
  - Joint Hypermobility Syndrome (JHS)
- 22 women with JHS = 43%

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Conclusions

- Tendency for lower strength in JHS
- No difference in cross-sections between JHS and GJH
- Correlations between dimensions mainly moderate
- Limitations
  - No control group with normal mobility
  - Group was too small

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Chapter 6. Resistance Training & Hypermobility

Krafttraining bei Frauen mit generalisierter Hypermobilität: Machbarkeit, Beschwerden und Effekte

Resistance Training in Women with Generalized Joint Hypermobility: Feasibility, Symptoms and Effects

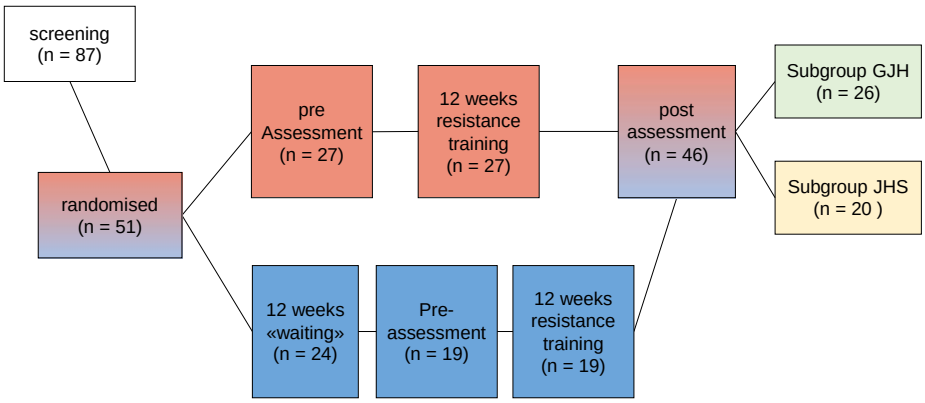
Problem of dissemination …

- Knowledge transfer known to be difficult…
- Language barrier
- Main publication not in physiotherapy journal

A possible solution …

- Additional publication in a German physiotherapy journal
- Consent obtained from faculty

Study design: pre-post study



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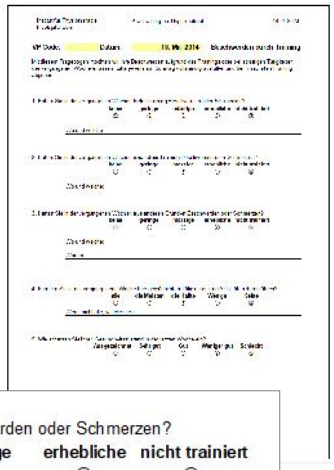
Complaint questionnaire

- Same training
- Same assessments
- Focus on discomfort and pain
  - Weekly questionnaire
  - Discomfort or pain during or after the training



1. Hatten Sie in der vergangenen Wochen **beim** Training Beschwerden oder Schmerzen?

keine	geringe	mässige	erhebliche	nicht trainiert
①	②	③	④	⑤

Wo und welche:

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Weeks with discomfort or pain

	All (n = 403)	Generalized Joint Hypermobility (n = 249)	Joint Hypermobility Syndrome (n = 154)
None during training	265 (66%)	192 (77%)	73 (47%)
Low during training	111 (27%)	42 (17%)	69 (45%)
Moderate or significant during training	27 (7%)	15 (6%)	12 (8%)

Luder et al. (2023) Resistance training: feasibility, complaints, and effects – pre-post study Physioscience

Training weight on leg press [% of body weight]

	All (n = 40)	Generalized Joint Hypermobility (n = 25)	Joint Hypermobility Syndrome (n = 15)
Week 1	44 %	46 %	42 %
Week 12	86 %	91 %	78 %

Luder et al. (2023) Resistance training: feasibility, complaints, and effects – pre-post study Physioscience

Discussion

- Feasibility of the 12-week programme is good
  - Few dropouts
  - Good adherence
  - Little discomfort or pain
- Implementation questionable
  - Low starting loads
  - Little increase during training
- Small and not significant effects
  - High individual variability

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Chapter 7. General Discussion

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The short answers …

- Is resistance training feasible and safe for women with joint hypermobility?
  → Yes, resistance training is a possible treatment option and the risk for pain and injuries seems not increased.
- Can women with joint hypermobility increase strength and muscle mass by a 12-week resistance training program?
  → Not necessarily, at least not with the self-guided 12-week training program.
- Does the 12-week resistance training have any influence on daily activities such as stair climbing and disability in daily life?
  → Likely not. In the present study no changes were seen for activities like stair climbing and daily function.

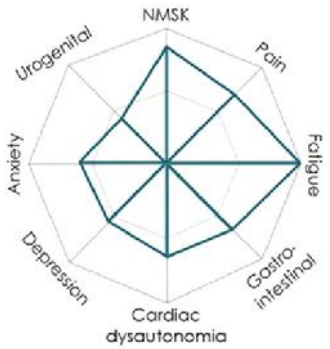
Resistance Training for Joint Hypermobility

- Findings of our study
  - Individual changes of strength
  - Possible fear of high weights and associated pain
  - More guidance and individual prescription necessary
- Findings from other studies
  - Strength gain for hypermobile persons similar to healthy
  - Better shoulder function after 16 weeks high-load strengthening
  - Reduced pain and increased QoL, strength and stiffness by 12 week resistance training -> completely supervised

Daman 2019; To & Alexander 2019; Liaghat 2022; Henriksen 2022

Developments in "Hypermobility"

- General development of definitions and diagnosis
  - New classification 2017
  - Discussions on Beighton score
- Lack of specific assessments
  - Spider: Recording of additional symptoms [2020]
  - Bristol Impact on Hypermobility Questionnaire [2017]



Luder 2015; Malfait 2017; Malek 2021; Simmonds 2022; Palmer 2017

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Clinical Implications

- Resistance training as basic approach to increase muscle strength and mass.
- Preparatory phase to improve motor control, using lower weight and more repetitions.
- Adding functional exercise and proprioceptive training, like standing on wobbly surfaces, balance or jump exercise.
- Movement speed first slowly and controlled, later variable speed, including quick contractions.
- End-positions of joints better avoided, also in daily life.

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Further Research

- Identify and validate specific outcome measures
- Identify proper types and modes of exercises
- Explore relation between physical fitness and response to training
- Ideas for next projects
  - Single-case studies for management
  - Translation and validation of Bristol Questionnaire
  - Testing of additional assessments
    - Upper Limb Hypermobility Assessment Tool
    - Lower Limb Assessment Scale

Tate 2020; Palmer 2017; Nicholson 2018; Johnson 2019; Ferrari 2005

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Chapter 8. Strengths & Limitations

- First randomised trial looking at resistance training
- Adequate group size, complete analysis
- Clear and structured training programme
- Broad range of assessments

Limitations

- Heterogenous study group
- Partially sub-clinical population
- Functional assessments not enough demanding
- Questionnaires not specific

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Chapter 9. General Conclusion

- Individually tailored physiotherapy, including resistance training, is useful in the management of hypermobility disorders.
- Structured and concise tools to assess symptoms and disorders in various dimensions are needed for clinical and research use.
- More concise assessments than the Beighton score, including additional joints, might help for diagnosis and classification.

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A very big «Thank you» goes to …

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… the co-authors: Christine Müller Mebes, Bettina Haupt-Bertschy.

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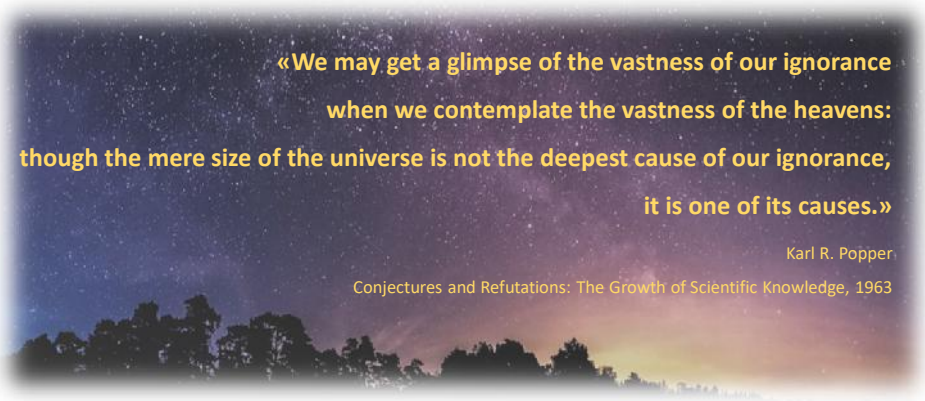

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