Aquatic Therapy and Falls prevention.

The use of Halliwick and Ai Chi in the geriatric population. Implementation of EBP.

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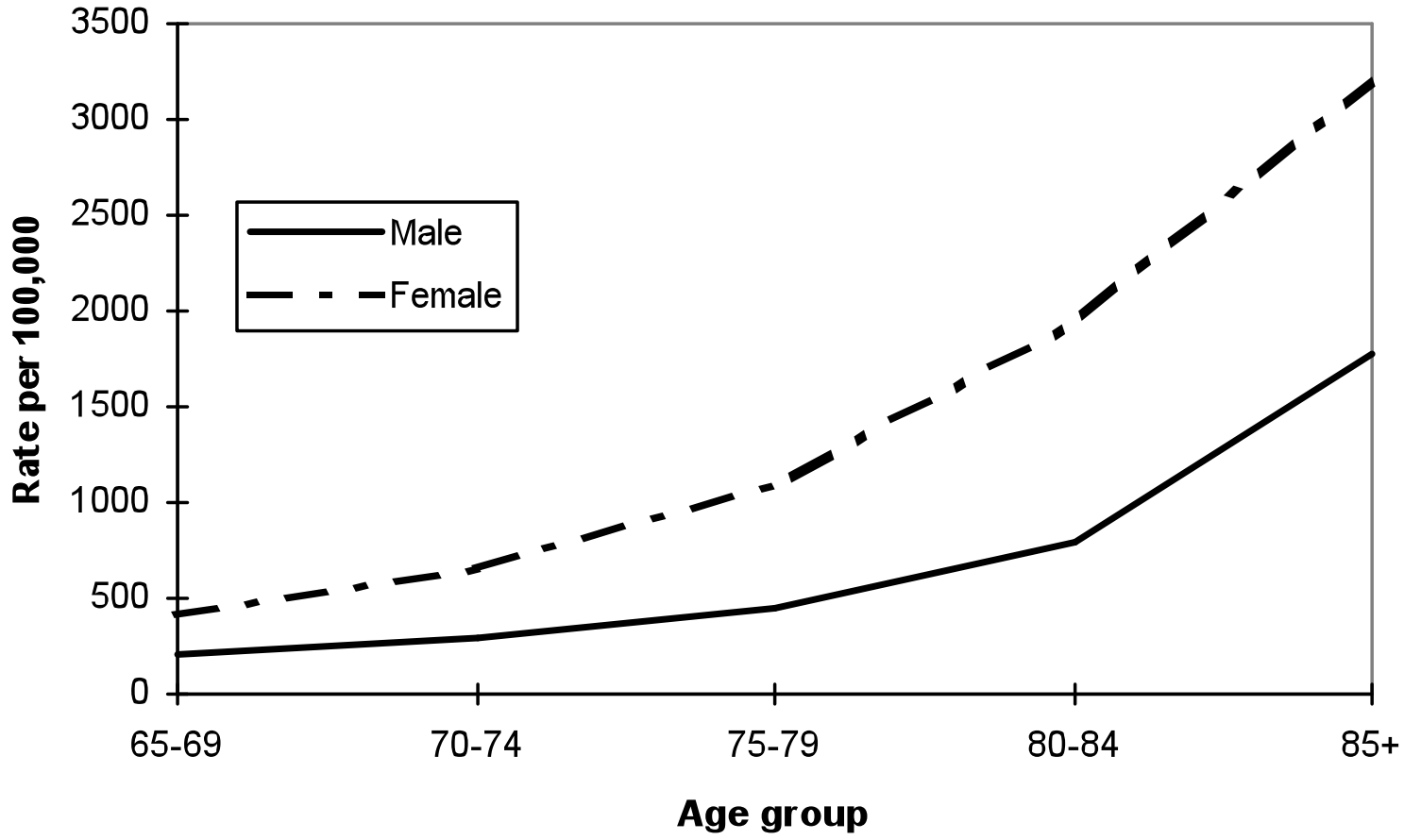
- Risk factors in geriatrics
- Human balancing strategies
- Fall prevention programmes
- Hydrotherapy: it's role in fall prevention
- Water Specific Therapy:
  - Halliwick
  - Ai Chi
  - The obstacle course

Risk Factors

Epidemiology

- 30 % of persons older than 65 fall at least once a year; in the 80 – 90 year old category, falls increase to 45 % once a year. Rubinstein cs, 1988
- WHO: fall related function disorders at 3rd place worldwide
- USA: 250.000 osteoporotic hip fractures annually, 90% because of falling

Hospital Admission Rates for Falls



Source: Cryer et al., 1993

Loss of balance: falling

- Represents a failure to meet intrinsic and extrinsic demands of mobility in a specific environment
- 50 % fall because of intrinsic factors: regular/ multiple fallers
    - Age and disease
- 50 % fall because of extrinsic, environmental factors: accidental fallers Duysens, 2007

Intrinsic factors
Falls are correlated with:

- Muscle strength of the legs, e.g.:
  - Tibialis Anterior, Triceps surae, Quadriceps Vastus Medialis, Hamstrings, Abductors, Adductors
- Range of Motion legs and lumbar spine
  - 70% has ROM limitations lumbar spine
- Walking balance (1 leg): 60% of falls because of slipping or tripping, foot getting stuck
- Single leg stance: e.g. while dressing
- Sitting down and rising from chairs
- Sitting and reaching beyond balance limits

- Lord 1994, Belgen 2006

More intrinsic factors

- Use of (psychotropic) medication that decreases reaction speed, esp. at start or during chronic use . Also: prednisone, cytostatics
- Problems with (depth) vision, double-focus glasses
- Changes in blood pressure
- Changes of blood sugars
- Changes of cognitive possibilities to judge dangers incl Alzheimer
- Low body mass index
- Diseases: rheumatological, Parkinson, stroke

Stroke

- Strength explains a significant part of low ratings at tests like Berg Balance Scale, Timed-Up-Go and Falls Efficacy Scale
- When both strength and balance are affected: risk of being severely walking disabled is 10 times higher than when having only one function impairment
- Fear of falling increases falls chance with 1.8 ×
- In long-term chronic stroke, falling does not increase. People learn to adapt to their balance limitations and avoid compromising situations

  – Pantanen J. Geronyology 1999, Belgen B, APMR 2006

Parkinson and falling

- 70% of the patients fall once a year
- 46% of the patients fall once a week and 33% fall even at least twice a week

- 25% has fractured a hip within 10 years after diagnosis
- Fall problems start about 10 years after the first symptoms

- 70% of falls are caused by patient related factors
- 9-fold increased risk of recurrent falls
  - King et al 2008, Bloem et al 2001

Predictors

- Parkinson:
  - Severity and length of the disease (Hoehn/Yahr >2)
  - Previous fall
  - Absence of arm sway
  - Dementia
- Stroke
  - Cutoff scores to identify fall risk in stroke vary from 45 to 52 on the Berg Balance Scale
    - Belgen B, APMR 2006

Risk factors and rheumatology

- Age > 55 years
- Osteoporosis
- Use of corticosteroids
- Decreased ROM and strength
- Nociceptive inhibition of proper arthro-kinetics
- Unsteady posture and gait

Non-vertebral fracture risk in postmenopausal women

	No index value	Highest index value
Age	< 65	> 80
Height	< 147	> 167
Femoral neck T score (BMD)	> - 1.4 (SD below mean	< - 3.8 of young adults)
Vitamin D	> 90 ng/ml	< 30
Prevalent vertebral fracture	0	>7 > 1.5 cm length loss
Prevalent non vertebral fracture	no	yes

Roux C et al, Ann Rheum Dis 2007, 66, 931-935

Practical fall risk predictors

- Fall history of at least 2 times the previous year
- Minumum 2 factors from the next:
  - 5 minutes walking without a cane
  - Cutting toe nails oneself
  - Sitting down / standing up without a problem
  - (un)dressing oneself
  - Frail and over 80

Balance strategies

Balance is:

- Task specific
- Context specific
- Still similarities in balance strategies

Balance strategies non-intentional movements

- Predictive/preparation

  expected prevention, = predominantly dynamic
  - Counter-weight, dynamic reactions that accompany intentional movements
  - Static mechanisms:

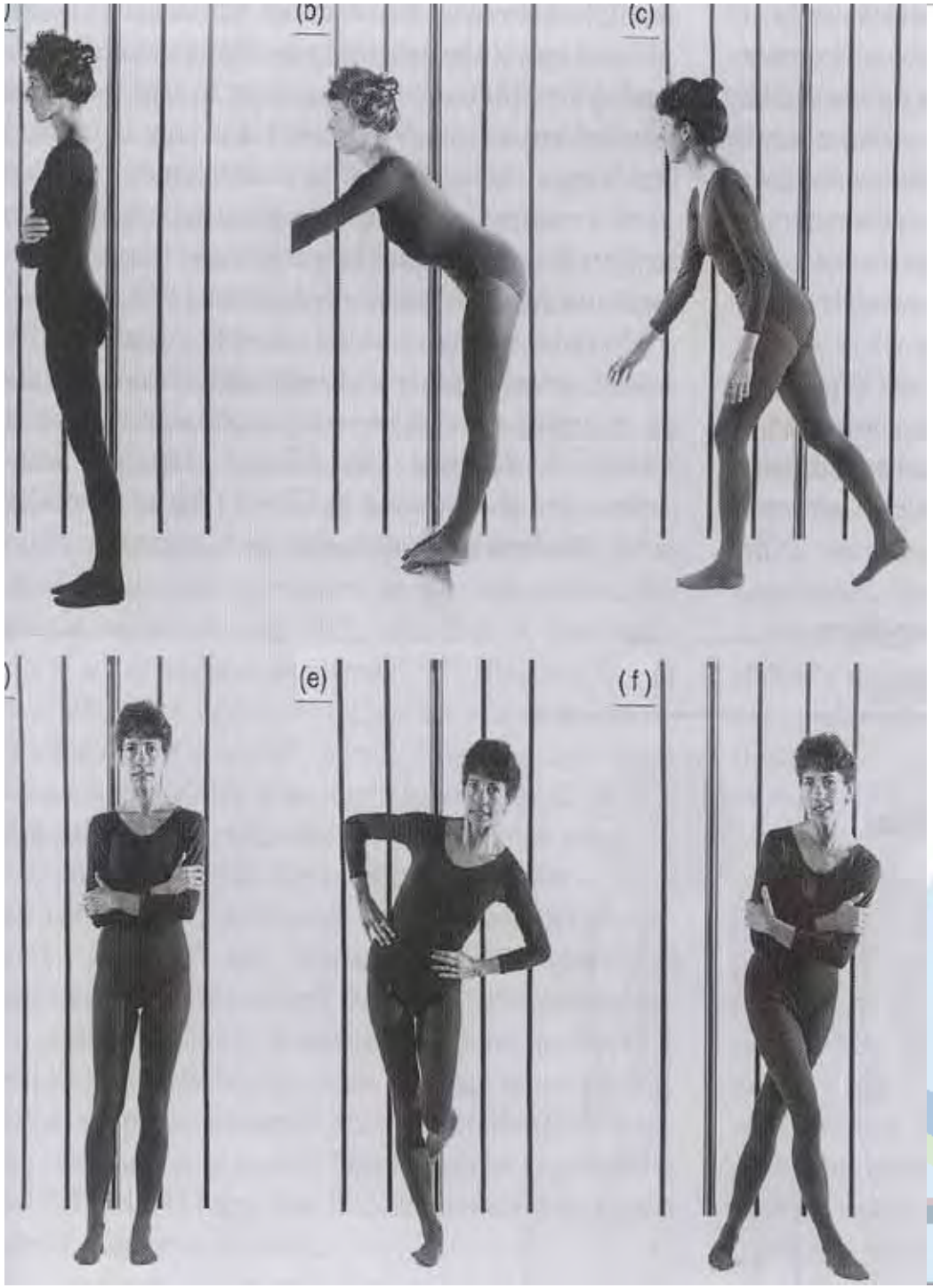
    - stiffening joints

    - increase base of sup.

- Reactive/correction

  unexpected loss
  - Ankle/hip strategies
  - Insecurity strategy
  - Stumble strategies
    - Sideways, backward
    - Forward
  - Arm strategy
  - Fall strategy

Guccione cs 2001, Bronstein cs 2004, Pijnappels 2005



Ankle strategy

Hip strategy

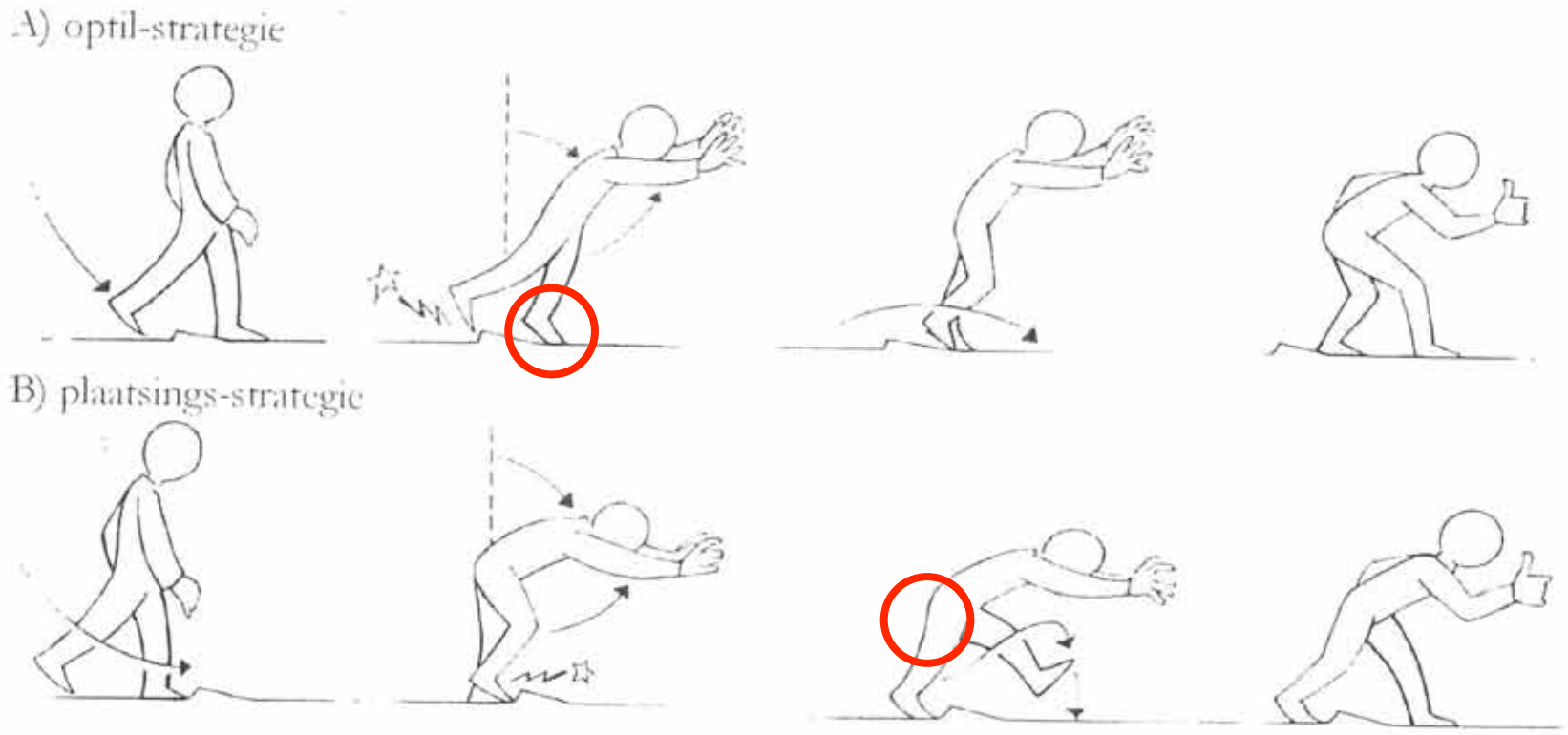
Stepping/stumble strategy

Bronstein A, et al (2004)

Clinical disorders of balance, posture and gait

Stumble strategy

- When the centre of gravity falls over the limit of stability: a leg and/or an arm is used for support
  - Sideways: with / without crossing feet
  - Backward
  - Forward
    - Stepping strategy
    - Suspension strategy



A. Suspension strategy

B. Stepping strategy

Pijnappels M. *Fysiotherapie en Ouderenzorg, 2005*

>> stumbling sideways is more dangerous: femoral neck fractures!! > Walk fast!

Negociate/avoid obstacles

- Short step and long step strategy
- Research:
  - Reaction speed can hardly be influenced
  - Elderly choose the long step
    - Hamstrings have too less braking force to rely on a short step
  - Long step often too short and low
- Training: elongate and heighten the step

Recently more focus on lateral balance loss

Balance problems during specific sets of intentional movements

Initiation (go/stop)

- Maintain weight-bearing during a task
- Limits of reaching
- Single leg stance
- Obstacle negociation
  - Inclusion of other constraints like cognitive dual tasks, darkness etc

No strategy at all and no freezing

Fall prevention programmes

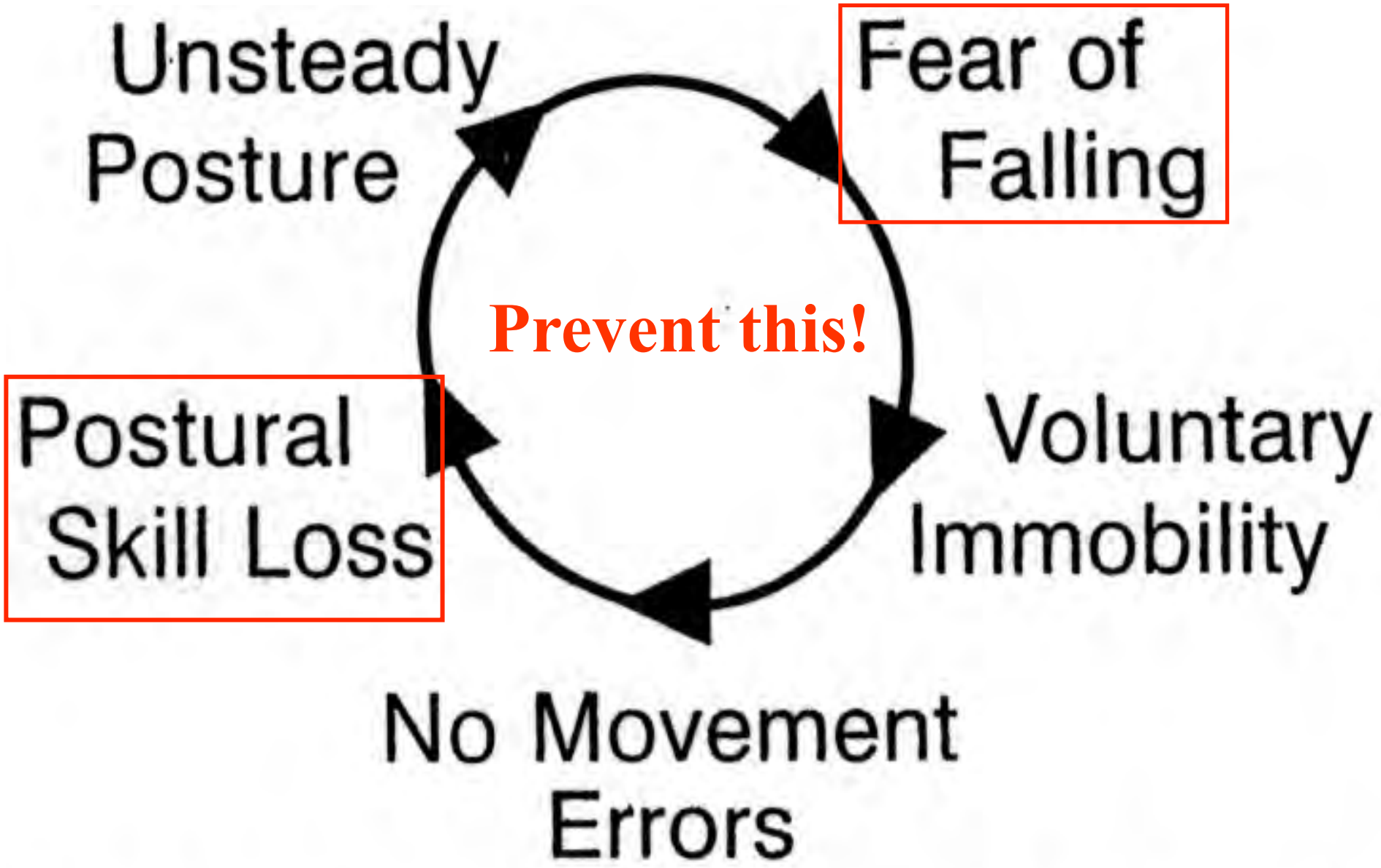


Figure 1. The cyclical effects of immobility on balance control in an elderly subject.

Simmons & Hansen, 1997

FICSIT land programme

- Interventions that include balance training significantly reduces falls

- Balance training is also important to become aware of the limits of stability

- Frailty and Injuries: Cooperative Studies of Intervention Techniques, Province, 1995 and Takazawa 2003

Training programme

- Balance incl single stance activities
- Isokinetic muscle strengthening for hip knee and ankle
- Tai Chi
- Obstacle course
- Flexibility/strength exercises on a mat
- Standing up again
- Judge 1993

Nijmegen fall prevention

payed by insurance because: evidence based

Weerdesteyn 2004

- Based on:
  - the “stimulating landscape” Mulder
  - Stumble research Duysens
- Components:
  - Obstacle course + double tasks
  - Group activities (anticipate other people)
  - Learning to fall (judo)
  - T’ai Chi
  - Halliwick in a pilot study (Smulders, 2003)

Problems

- Walking may lead to slipping, stumbling or falling when at the same time, the person has to:
  - Maintain direction
  - Vary gait parameters
  - Perform a dual / multi task
    - Memorize, carry objects, sing / talk
  - Negotiate obstacles and/or people
  - Walk with poor light conditions

Results from “Nijmegen“

- Elderly:
  - Medio-lateral sway increased
  - 80% of time we look around when walking, rotation of the spine has decreased > more foot turning
  - Stumbling: e.g. hamstrings react well (only 6 ms later as the younger) but with a low amplitude
  - Long step strategy is chosen often (but just too short)
  - Knee flexion is less when negotiating obstacles
  - Show less gait variability
  - Have more problems on non compliant surfaces

Tai Chi

- TC improves strength, balance and decreases functional limitations, based on self-rating. Compared to e.g. water aerobics TC is a desirable alternative that provides similar health and social benefits
- TC does not improve measures of postural stability in older objects, it promotes confidence (fear of falling questionnaire)

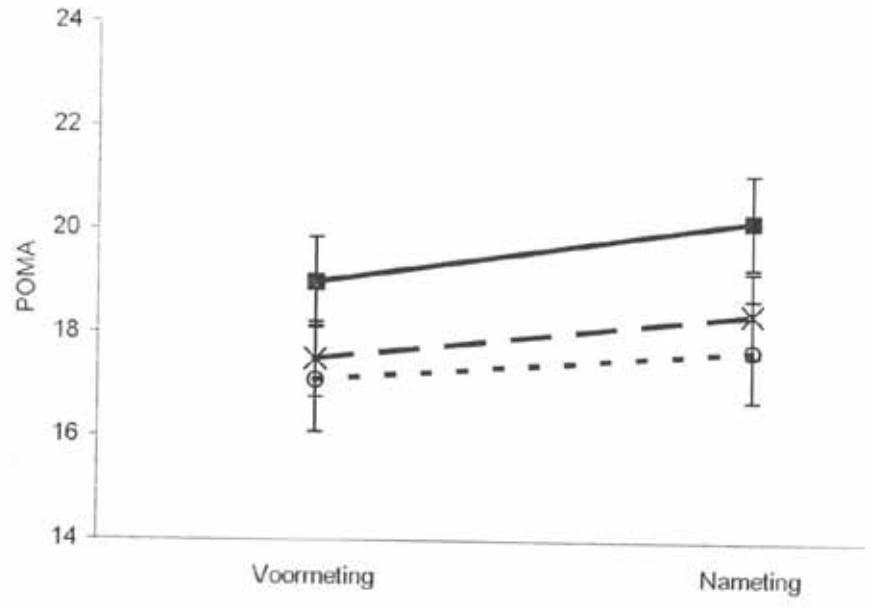
- Fall risk is reduced by 47.5%

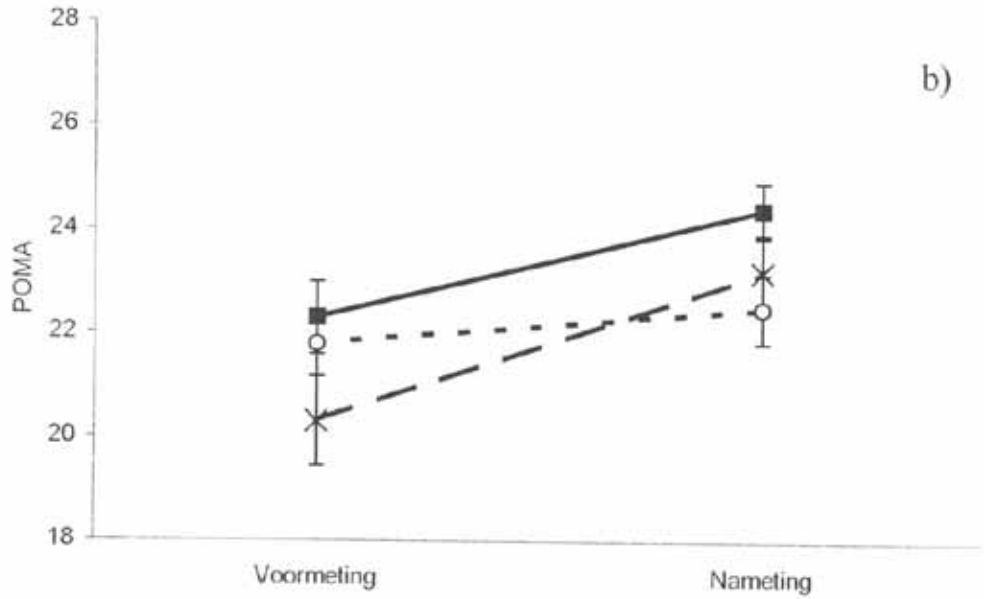
- Wolf SL et al. J Am Geriatric Soc, 1996 and Physical Therapy, 1997
- Lan C, et al. Med Sci Sports Exerc, 1997.
- Li F, et al. Ann Behav Med, 2001

Effects of 'In Balans' (T'ai Chi)

- **Project Free University A'dam 2003-2005**

  - frail elderly (high fall risk, average 85 year)
  - 2x/week;
  - test: POMA / Tinetti
  - effects:
    - * 38 % scores higher
    - * controls decrease 5%
    - * reduction of fear not proven, although pp perceive less fear
  - 1 y after the programme, still a fall reduction of 51%





------- = Obstacle course; - - - = Tai Chi; …… = Controls

Age 85 y, N = 278, 20 wk, 2/wk

Fall incidence decreased with 29% in the Obstacle course group and 45% in the Tai Chi group.

Faber M et al, *Fysiotherapie & Ouderenzorg 2005*

Most important:

- 3 variables explain 68% of the effect of exercise on fall rate:
  - Highly challenging balance exercises, include:
    - Movements of the centre of mass
    - Narrow base of support
    - Minimized upper limb support
  - High total dose: >50 hours (25 weeks à 2 h/wk)
  - Avoiding a walking programme
    - Valid for home dwelling and nursing home residents
    - In general 17% fall reduction. Higher % for multiple fallers and nursing home residents
      - Sherrington C, etal. J Am Geriatr Soc 2008
      - SR based on 44 RCT‘s

Therapy variables for posture

- Maintaining a posture
  - Narrow basis, minimized use of hands
- Self initiated change of posture
  - Change of the COM (esp medio-lat)
- Preparation – correction
- Perturbations: expected - unexpected

Therapy variables for gait

- Maintain direction
- Vary gait parameters
- Perform a dual / multi task
  - Memorize, carry objects, sing / talk
- Negotiate obstacles and/or people
- Walk with poor light conditions

Additional

- Mobilisation (and disassociation) of spinal rotations, no foot turning
- Strengthening: hamstrings, calfs etc
- Increase step length when negotiating
- Increase knee flexion
- Add gait variations
- Work with non compliant surfaces
- Teaching how to fall

Hydrotherapy

- Can hydrotherapy be used in a fall prevention programme?

Guidelines with hydrotherapy

- UK: Chart Soc Physio, Nat Osteop Soc, 2001
  - Csp osteoporosis guideline
    - There is no evidence to suggest that hydrotherapy has any effect on bone mineral density. However, there is evidence that other physiological parameters can be affected, such as muscle strength, aerobic capacity and pain control. There may also be an increase in psychological wellbeing
- Australian and New Zealand Bone Mineral Society, 2000
  - Position Statement
    - Individuals who are frail, severely kyphotic, or suffer from pain or poor balance may benefit from hydrotherapy
- Hungarian guidelines (G. Balint, ISMH 2006, personal communication)

Publications: balance and hydrotherapy

Author		Quality	effect	patients	test
Lord, 1993	CCT	2/10, 3a	Positive ss	Elderly	Body sway
Morris, 1996		4	Positive	CVA	F. Reach
Simmons, 1996	RCT	3/10, 2b	Positive ss	Elderly	F. reach
Maginnis, 1999		4	positive	Elderly	Berg, TUG
Muhlenkamp, 2000		2b	Positive ss	Elderly	POMA
Thorpe, 2000		4	Positive ss	CP case	Functional reach
Suomi, 2000	RCT	4/10, 2b	Positive ss	RA and OA	Postural sway
Johnston, 2002		4	Positive	Parkinson	Berg
Suomi, 2003	RCT	5/10, 2b	-----	RA and OA	Modified TUG
Douris, 2003	CCT	3/10, 3a	Positive ss	Elderly	Berg
Yozbatiran, 2004	RCT	3/10, 2b	Positive	CLBP	Stance 1 leg
Smulders, 2005		4	Positive ss	Elderly	ABC
Devereux, 2005	RCT	7/10, 1b	Positive ss	Osteoporosis	Step test
Berger 2005	RCT	1b	Positive ss	LE trauma	Postural sway

No systematic reviews available

Balance

Effectiveness of water exercise on postural movility in the well elderlys: an experimental study on balance enhancement

5 weeks 2 times per week, 45 minutes. Ntotal = 52

Elderly subjects: 80 +/- 5.8 years

Measurement: Functional Reach

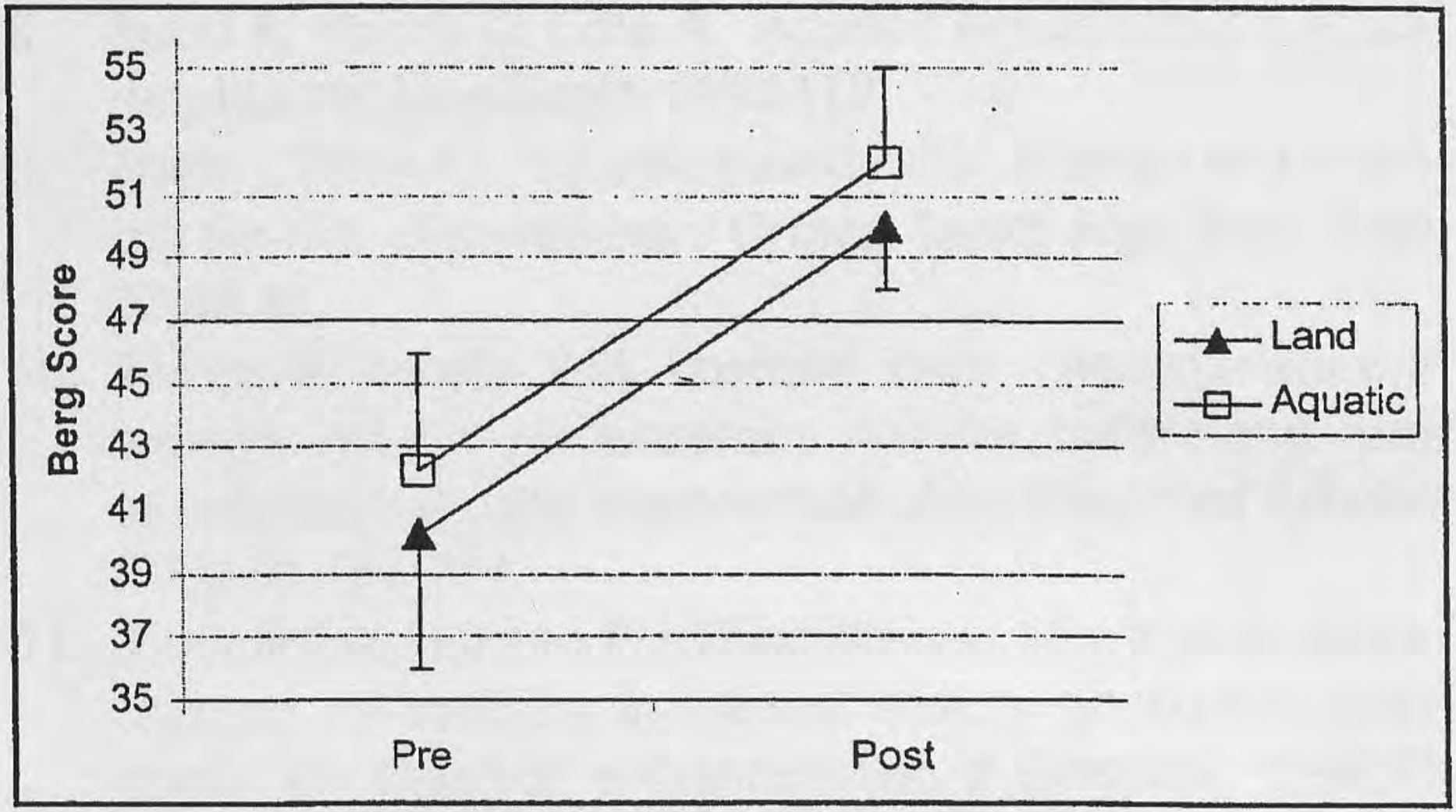
Initially: each group at risk, FR < 25 cm

Land sitting	Water sitting	Land exercise	Water exercise
23.6	24.4	28.7*	34.0*

Simmons V, Hansen PD: J Gerontol A Biol Sci Med Sci 1996

Simmons/Hansen: programme

- Walking forward, backward high stepping
- Marching for/backward with extended knees
- Sidestepping with/without crossing legs
- Balance on the spot: toe/heel raises etc
- Kicking in diagonals
- twisting



Douris, 2003, J Geriatric Physiotherapy

Same programme land and water

> not using water well?

n=6 land, n=6 water, 6 weeks, 2/week

Exercise protocol
Douris

- Walking activities, 3 times each
  - Walking and marching forward 11 feet
  - Side stepping without crossing 11 feet
  - Tandem walking 11 feet
- Exercise activities, 1 set of 15 reps
  - Marching in place
  - Hip flex/ext, abd/add
  - Toe raises and heel raises
  - Sit/stand from pool shelf
  - Shallow knee bends
  - >> not challenging enough?

In summary

- In all articles (ss) changes on balance because of exercise therapy in water
- Not always a ss difference between the intervention and control group
- Mostly simple exercise programmes
  - Sometimes (non)-intentional balance strategies included
  - Land-based exercises do not yield enough effects

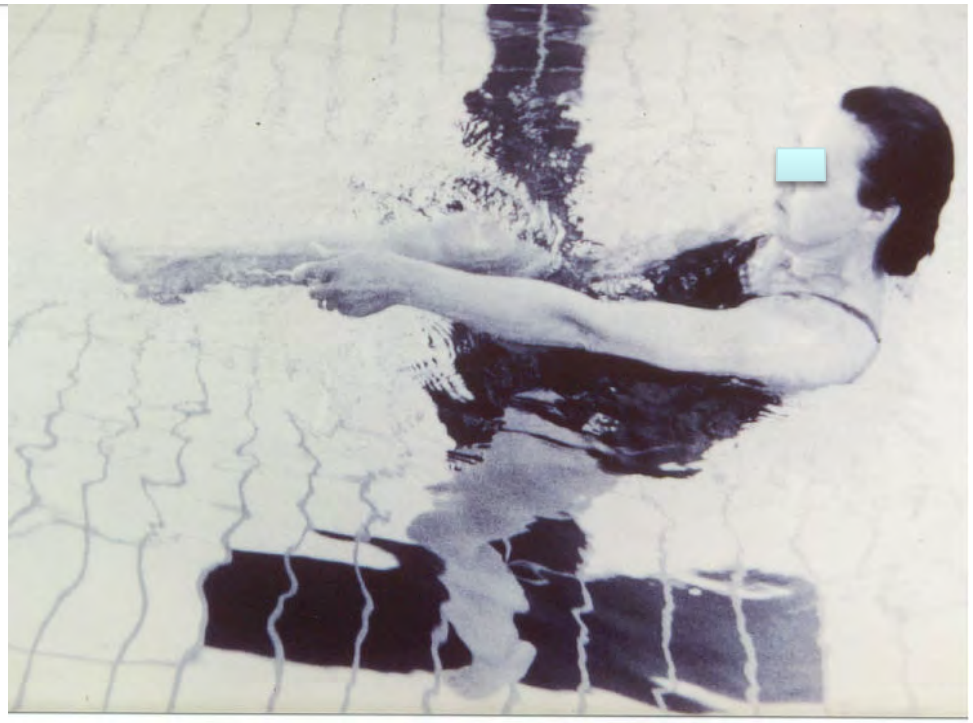
Water:

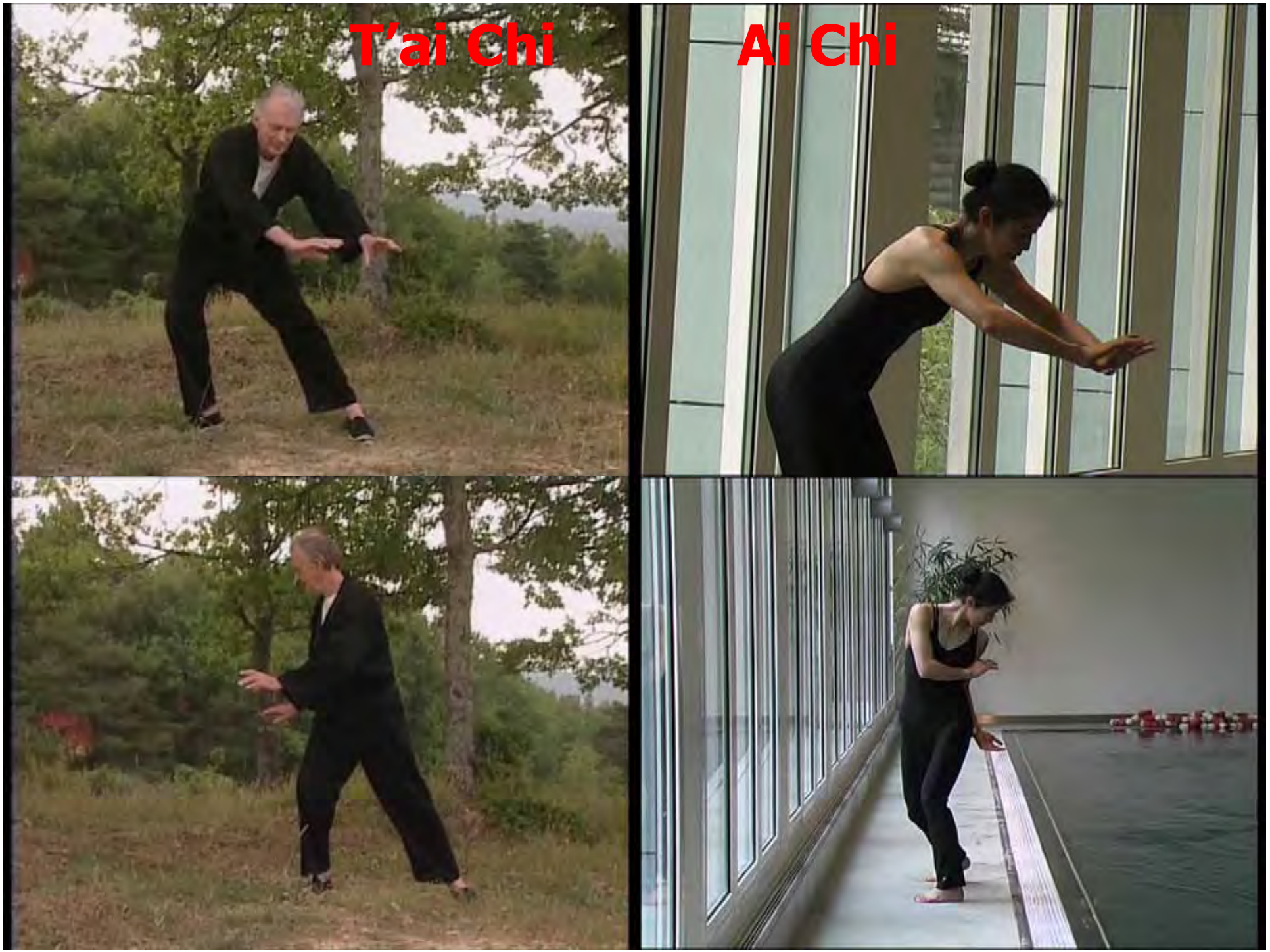
- Halliwick, Ai Chi balance and the obstacle course focused on intentional and non-intentional balance strategies at the ICF levels of body function and activity might be able to increase effects of aquatic therapy
- ICF: International Classification of Functioning, Disability and Health (World Health Organisation, 2001)

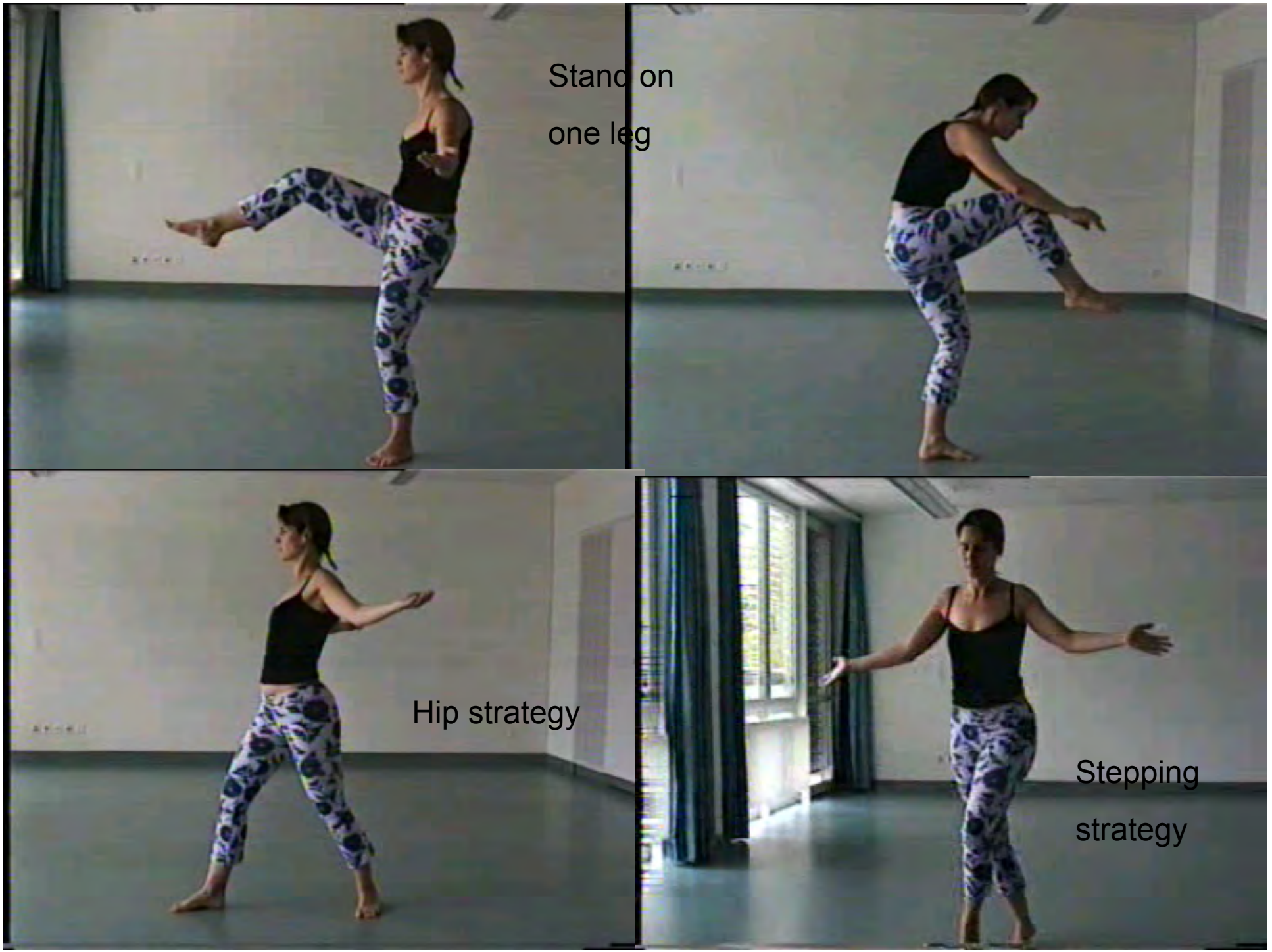
Halliwick 10 point programme, adapted:

- **Mental Adjustment**
- **Transversal Rotation Control**
- **Upthrust**
- **Sagittal Rotation Control**
- **Balance in Stillness**

As a preparation, to feel secure, for Ai Chi and other activities



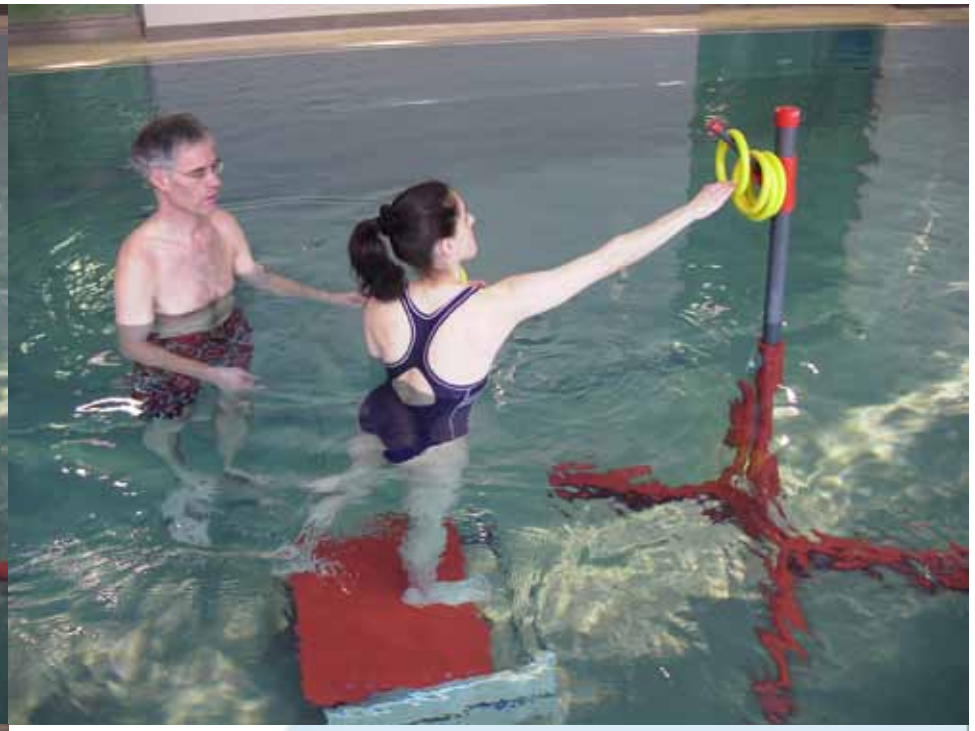

T'ai Chi
Ai Chi


Stand on
one leg
Hip strategy
Stepping
strategy

The aquatic obstacle course

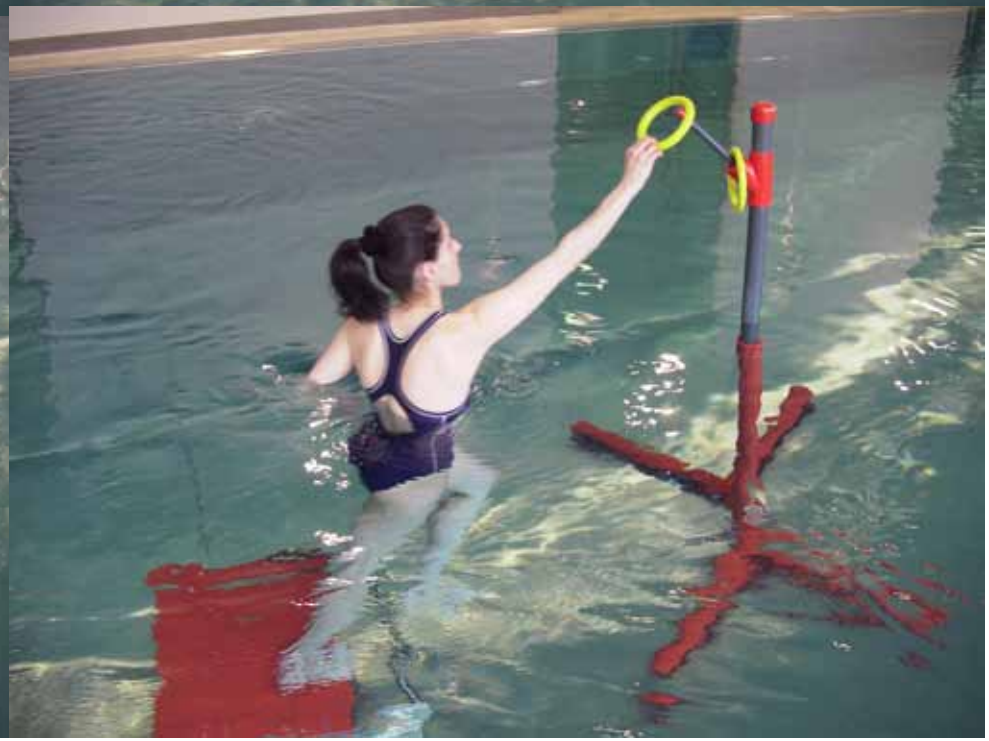
Formal course (design EWAC, NL)

Informal games and activities in which the intentional and non-intentional balance strategies are used



- No risk to fall

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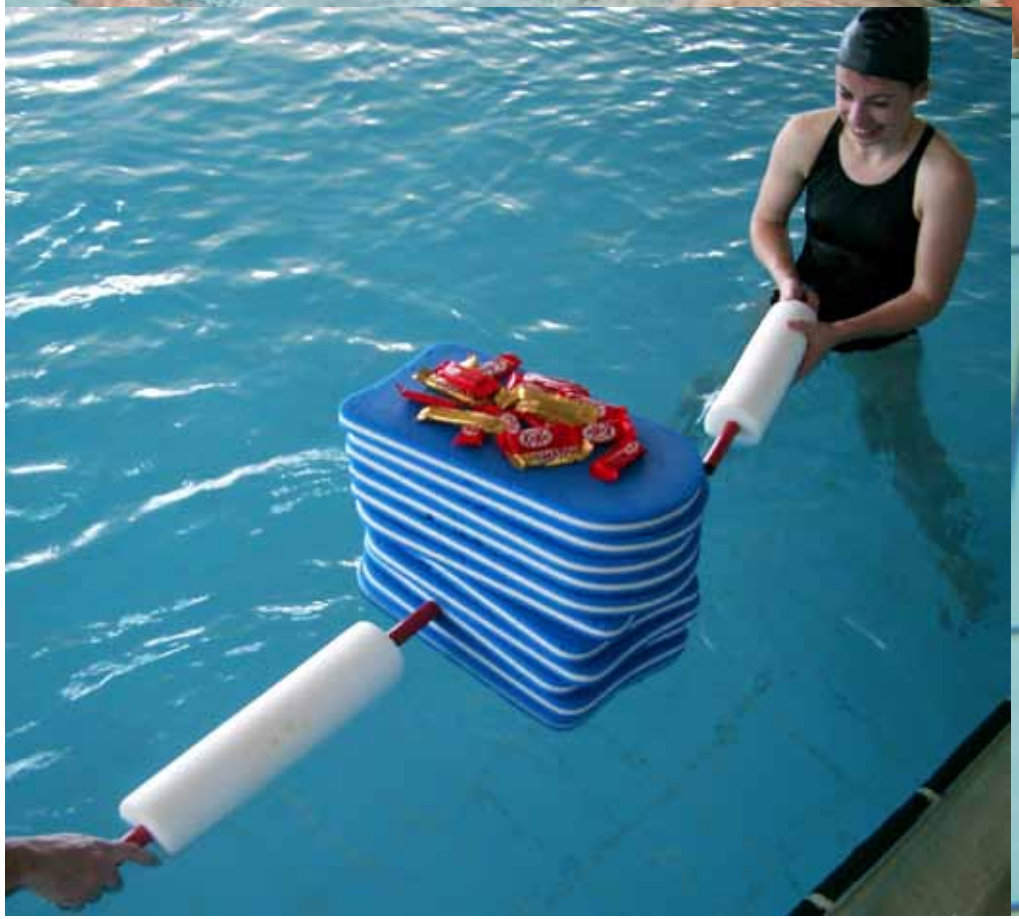


Hydro and T'ai Chi in knee OA

RCT by M. Fransen, Arthritis & Rheumatism 2007

- T'ai Chi: = 56, Hydro: n = 55, waiting list controls: n = 41
- Mean age = 70, minimum = 63 y
- 12 wk, 2/wk and 12 wk follow up
- > congruence hydro better than T'ai Chi
- > hydro larger improvements in objective measures of physical performance than TC
- > improvements sustained in follow-up

Effect sizes at 12 wk

	Hydro vs control	TC vs control
WOMAC pain	0.43**	ns*
WOMAC function	0.62***	0.63
SF12 physical	0.34	0.25
TUG	0.76	0.32
16m walking time	0.49	0.36

*: knee pain on land because of T'ai Chi position: semi squat

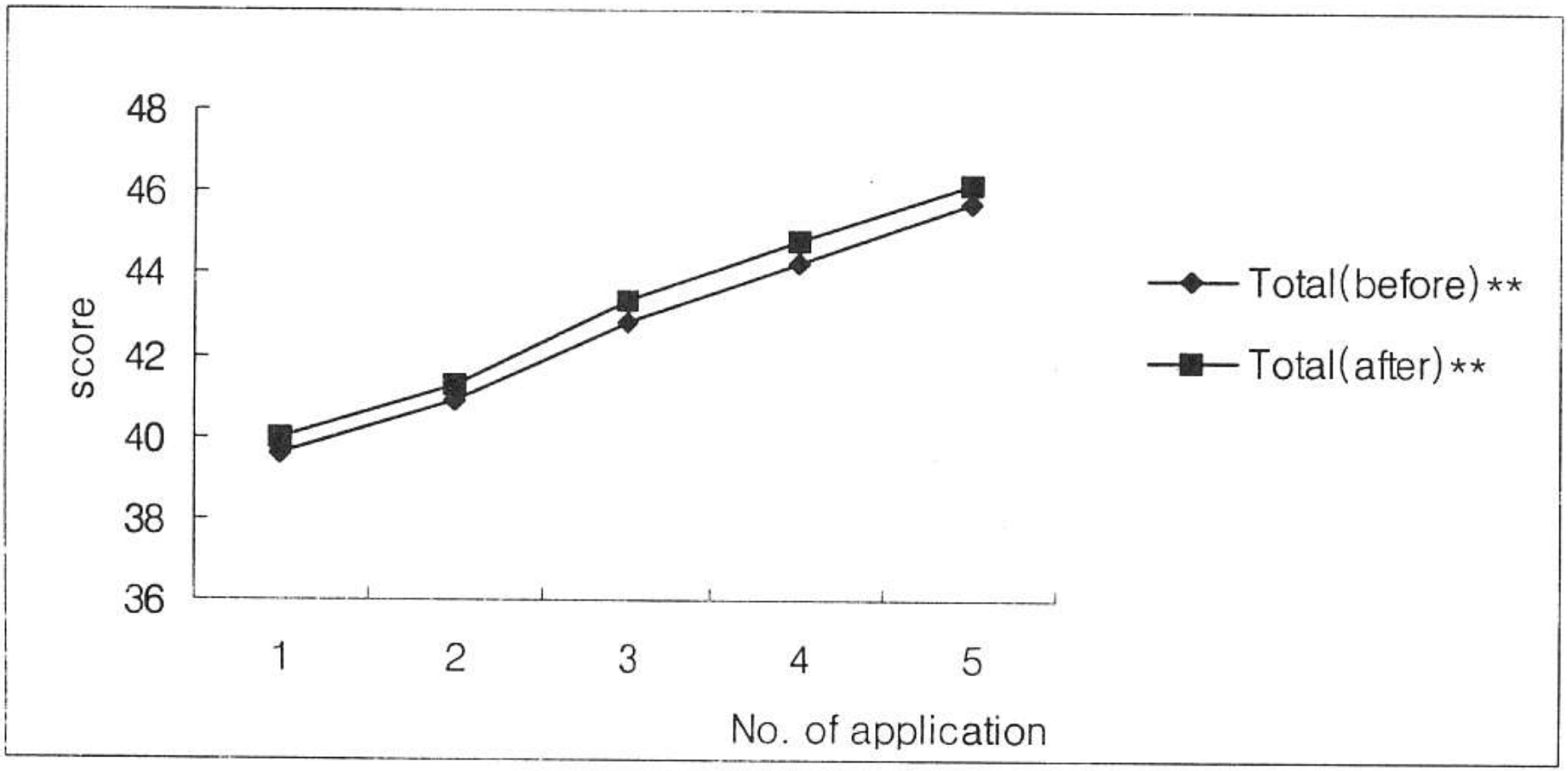
**: recent meta-analysis about graded exercise in knee OA: ES = same range for pain

***: same study: ES physical function (0.23 – 0.39) much lower than here

Stroke and balance

Bae Jung-Hyuk, MSc thesis 2006

- Cohort study: no matched controls
- N = 26, duration of CVA?
- Primary outcome: BBS
- 5 treatments
- Intervention: Halliwick
- Conclusion: ss increase of the total BBS score, as well as on some subscales



** p<0.01

Fig. 22. Mean changes of BBS total scores

BBS pretest: 39.58 ± 17.69, BBS posttest 45.73 ± 13.25

>> smallest detectable difference BBS = 3 (CI 95%), so change is not accidental

>> cutoff score to identify falls is 38 - 52

Stroke and balance

Nam Cheung-Hong, 2006

- RCT
- N = 26, onset = 20 ± 3.24 month
- AT vs Bobath (AT is mainly Halliwick 10p), 6 weeks, 3 times / week
- Measurements: baseline and 6 wk
- Tests: e.g. BBS
- Groups were baseline comparable

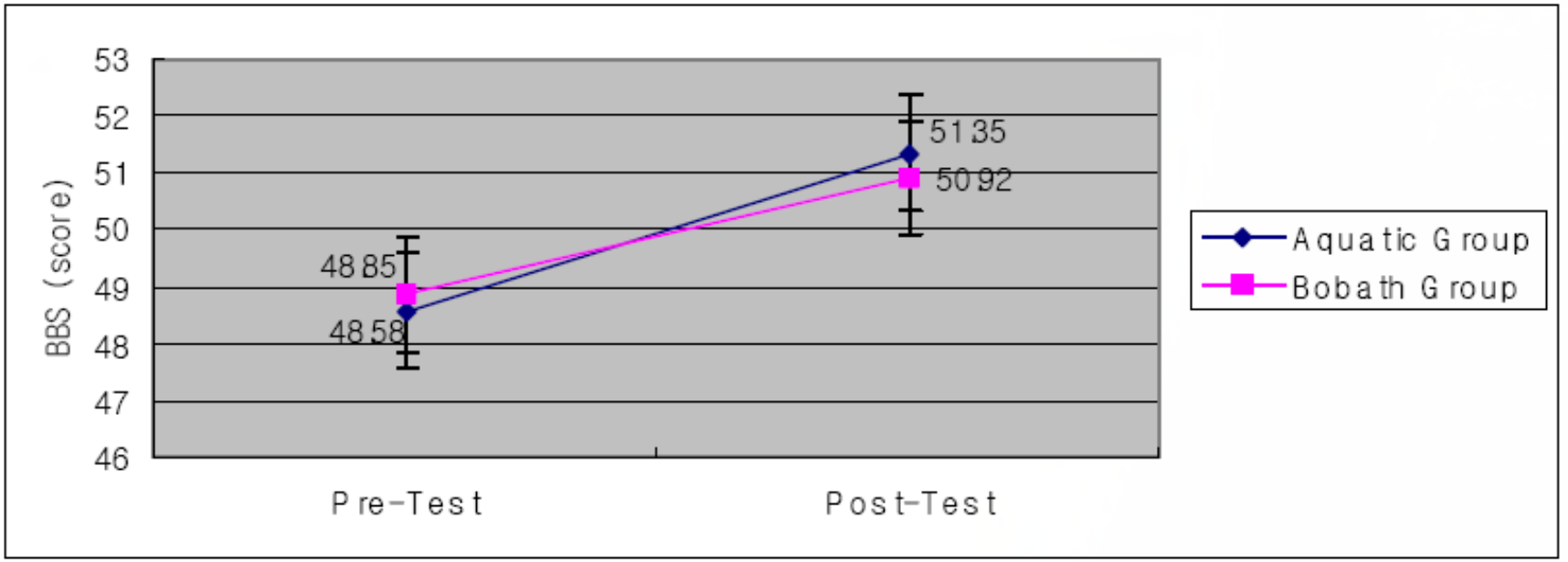


Fig 12. The change of Berg Balance Scale between the Aquatic and Baboth groups

BBS Bobath: pre 48.85 post 50.92

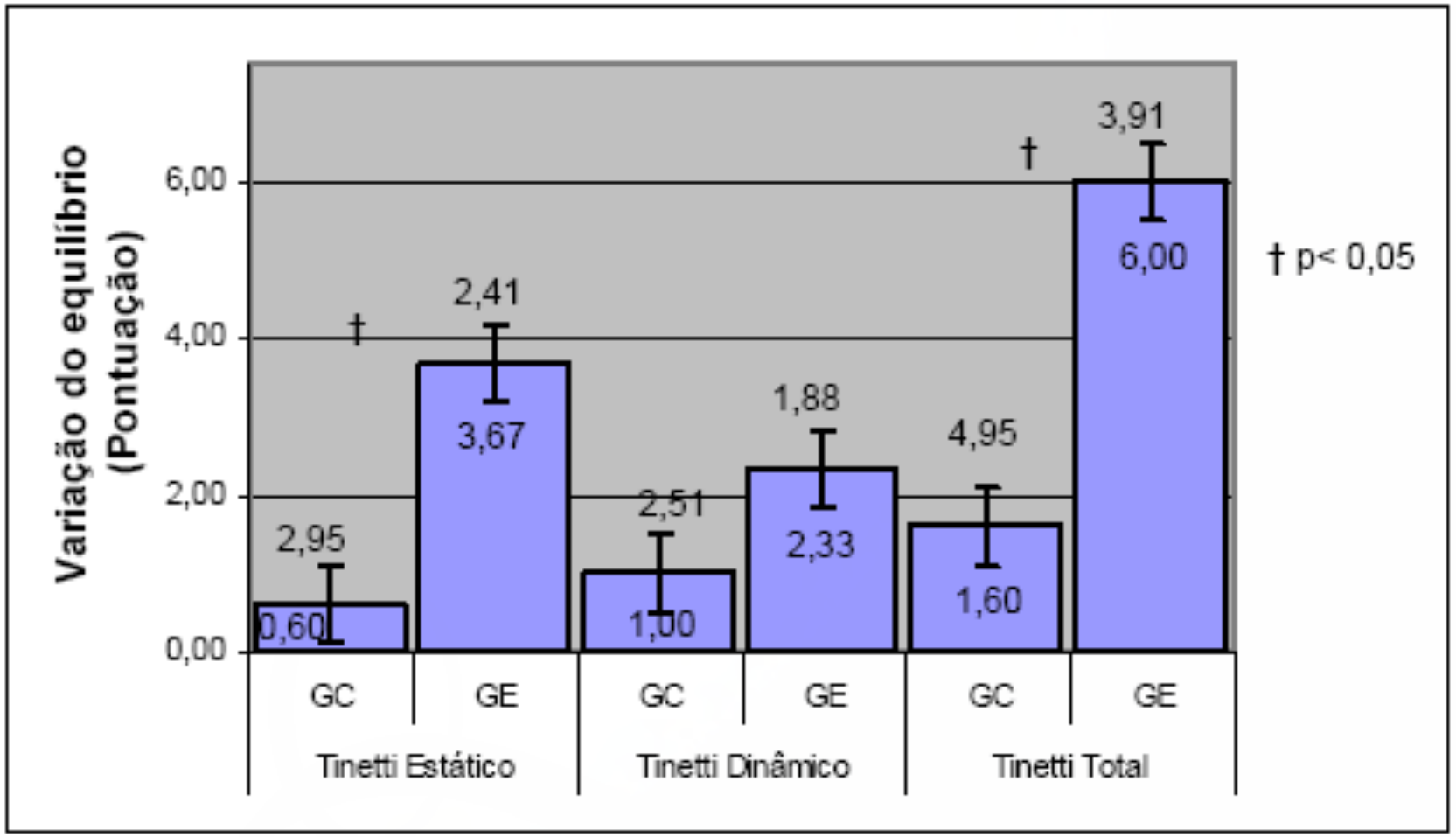
BBS AT: pre 48.58 post 51.35 , almost at the smallest detectable difference

Effect size very low: no difference between the 2 interventions

Why the negative difference with Bae (although here: 18 treatments). Other stroke group, not enough balance ex in the pool?)

Ai Chi research

- Teixeira R, et al. 2007
  - RCT: balance and fear of falling amongst older adults: total n = 30.
  - Age: 81 ± 3
  - Intervention: Ai Chi, 16 sessions / 6 weeks
  - Controls: usual living pattern
  - Assessment: POMA / Tinetti (max 24 of 28)
  - FES: Falls Efficacy Scale
  - No follow-up


Variação do equilíbrio (Pontuação)
6,00
4,00
2,00
0,00
2,95
0,60
2,41
3,67
2,51
1,00
1,88
2,33
4,95
1,60
3,91
6,00
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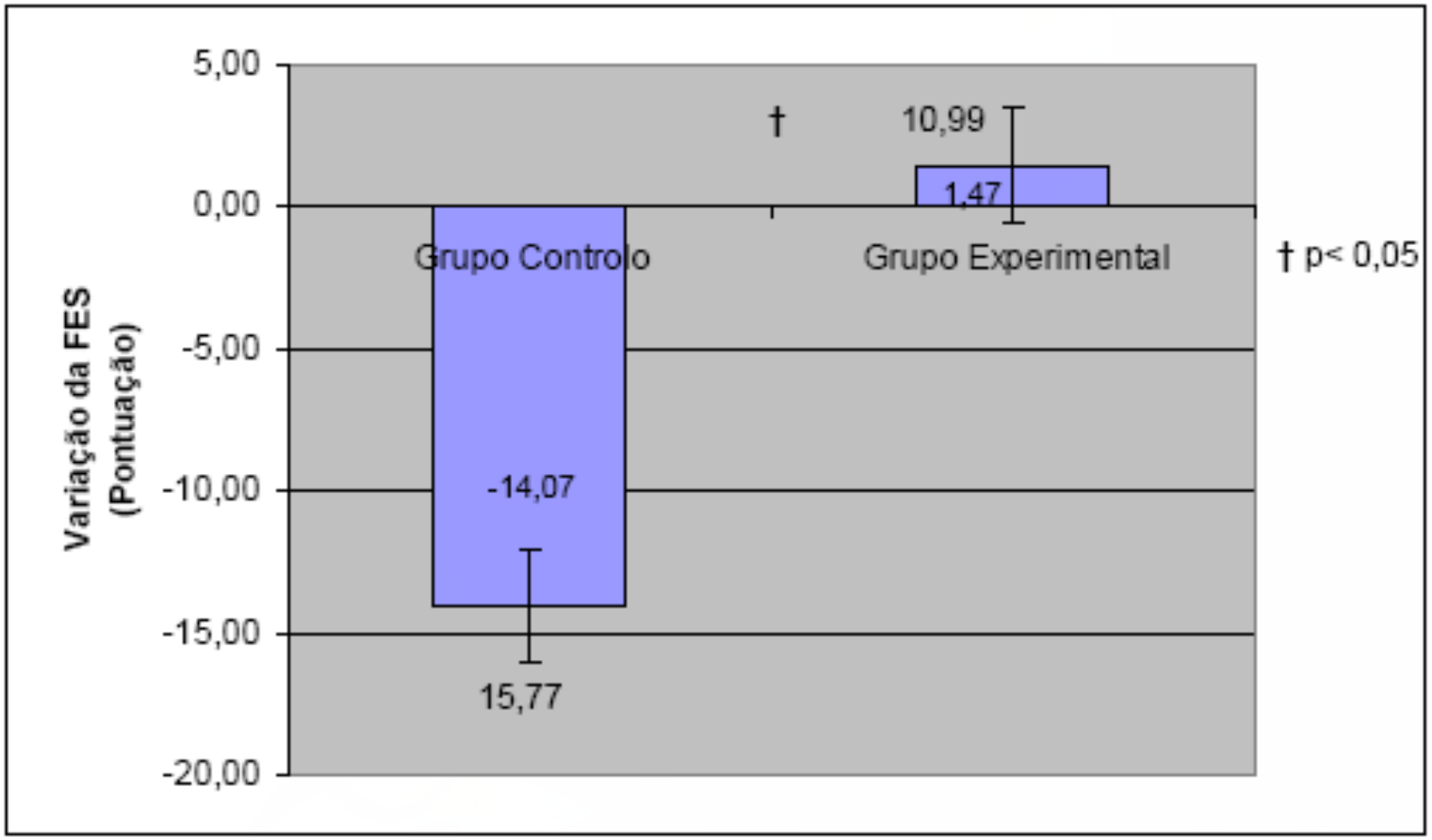
† p< 0,05
GC
GE
GC
GE
GC
GE
Tinetti Estático
Tinetti Dinâmico
Tinetti Total


5,00
0,00
-5,00
-10,00
-15,00
-20,00
Variação da FES
(Pontuação)
†
10,99
1,47
Grupo Controlo
Grupo Experimental
† p< 0,05
-14,07
15,77

	Ai Chi group intra		Controls intra		Inter groups	
	Poma	FES	Poma	FES	Poma	FES
Effect size d					1.3	1.55
Wilcox Intra: p =	0.001	0.306	0.254	0.011		
Mann-W Inter: p =					0.021	0.008

Noh Dong-Gook

Clinical Rehabilitation 2008

- RCT: Chronic stroke > 6 m.
- Intervention: Halliwick + Ai Chi (n= 9)
- Control: dry bicycle conditioning (n=8)
- Design: 8 wk / 3*wk / 1 hour
- Outcomes:
  - BBS, force plate weight bearing, gait (Modified Motor Assessment Scale), isokinetic strength

Noh programme

- Halliwick/Ai Chi (115 cm deep, 34°)
  - 5 min warming up
  - 25 min SRC weight transfer, TRC and CRC
  - 25 min Ai Chi rounding and balancing
  - 5 min cooling down
    - * supported by a pt when needed (only first week)
- Dry gym
  - Combination of bicycle ergometer, arm ergometer


Rounding
Balancing

Table 2.
Outcome Measure: Baseline and Posttest

	Experimental Group(N=9)		Control Group(N=8)	
Variable	Baseline	Posttest	Baseline	Posttest
BBS score(max=56)	45.0(17.0)	50.0(8.0)†‡	43.0(25.0)	45.0(25.0)
MMAS(max=6)	3.0(1.0)	4.0(3.0)†	3.5(1.0)	4.0(3.0)
More affected side				

P<0.05, sign difference between pre-post and between both groups posttest

Effect size = 1.3 (BBS)

Conclusion author: Halliwick and Ai Chi are effective in promoting balance and weight-bearing in people with stroke

Noh results 1

	BBS	Anterior weight bearing	Posterior weight bearing	Knee ext force	MMAS
Exp group	11%↑	7% ↑	12% ↑	22 %↑	30 %↑
	SS	SS		SS	
Controls	No Δ	No Δ	No Δ	5 %↑	12 %↑

Conclusion

- A-specific hydrotherapy programmes increase balance
- Specific programmes are available, important therapy variables are applicable in water
- These should have the potential to influence balance and underlying factors even more.
- This hypothesis needs to be confirmed through research