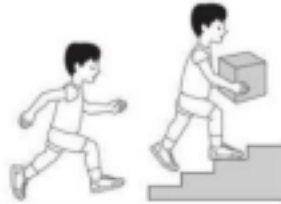


Assistive Technology,  
Seating and Mobility  
**Ergonomic Sitting and Seating**

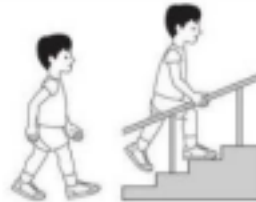
Lori Rosenberg PhD OT  
Hebrew University  
Ilanot School  
Jerusalem  
March 2021

**populations**



**GMFCS Level I**

Children walk indoors and outdoors and climb stairs without limitation. Children perform gross motor skills including running and jumping, but speed, balance and co-ordination are impaired.



**GMFCS Level II**

Children walk indoors and outdoors and climb stairs holding onto a railing but experience limitations walking on uneven surfaces and inclines and walking in crowds or confined spaces.



**GMFCS Level III**

Children walk indoors or outdoors on a level surface with an assistive mobility device. Children may climb stairs holding onto a railing. Children may propel a wheelchair manually or are transported when traveling for long distances or outdoors on uneven terrain.



**GMFCS Level IV**

Children may continue to walk for short distances on a walker or rely more on wheeled mobility at home and school and in the community.

III+ II+GMFCS I





Relationships in sitting



# WHEELCHAIR SERVICE TRAINING PACKAGE

Participant's Workbook

INTERMEDIATE LEVEL

Pelvis posture	Write or draw your observations of the person's changed posture. Look at the person's trunk, head and neck, legs.
<p data-bbox="198 78 475 114">Anterior tilt</p> 	
<p data-bbox="198 335 475 371">Posterior tilt</p> 	
<p data-bbox="198 592 475 628">Lateral tilt</p> 	
<p data-bbox="198 878 475 913">Rotation</p> 	

WSTP  
Intermediate  
Level  
Participant's

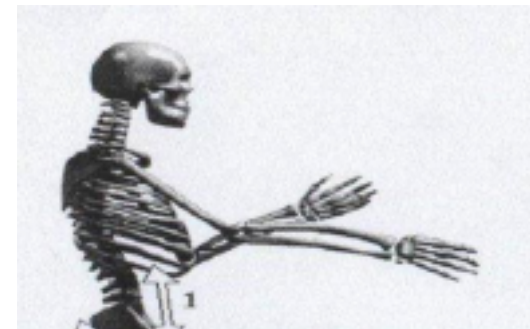
# Influence of body

- Angle of the pelvis-back
- Use of hands pelvis

2002 תמונה מ Engstrom

# Influence of body

- leg position - pelvis angle



- Pelvis position- neck
  - Drinking
  - writing

Engstrom, 2002

## Influence of sitting

- Using hands: writing
- Eating/drinking



# Regular sitting

- Seat height
- Crossing legs



(asymmetry) • Crossing

hands

- Saddle seating

## Regular sitting

- Tendency towards PPT:
  - Lack of stability on IT
  - Fatigue of the erector spinae
  
- Look around.....





# Regular sitting

- Active sitting
  - anterior pelvic tilt
  - Straight spine
  - Feet under knees
  - Elbows on table

Is this good or bad?  
Why?



# Regular sitting

- Passive sitting (comfort)
  - Posterior pelvic tilt
  - Rounded back
  - Back supported
  - Asymmetry
  - change

## Posture

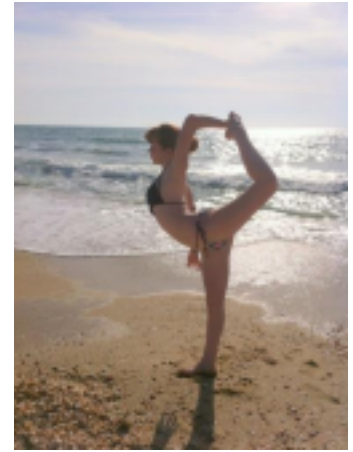
Posture:  
temporary  
arrested  
movement,



which is in a constant state of change

- Constant change
- Individual
- Multiple personal variations

(Howe and Oldham, 2001: Wandel, 2000)



"Every movement brings a blessing "

Variations through the day (PP&S)

Proximal stability distal movement?

Neville (2005)



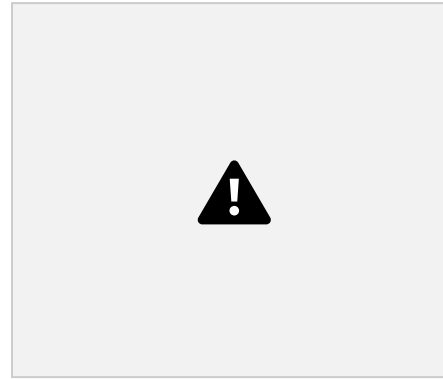
<https://www.bashgal.co.il/items/>[https://adhdshop.co.il/product\\_category/organization/proper\\_seating/](https://adhdshop.co.il/product_category/organization/proper_seating/)

## Children's posture

- Under 5 years



- lumbar + thoracic straight (not curved) – Shoulders forward
- Legs in adduction



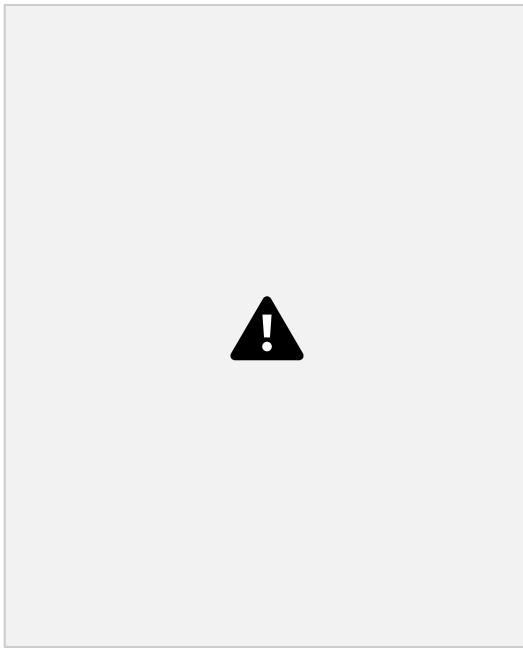
WSTP intermediate reference  
manual

## Seating (PP&S)

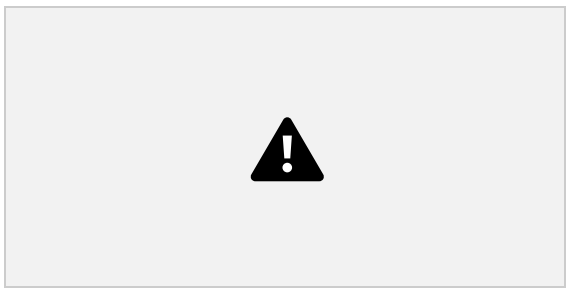
management or Posture  
management – 24 hour care  
– Seating, standing and lying

## Variation

- Posture, Positioning and



activity



huma

n

context

# PP&S





## Sitting

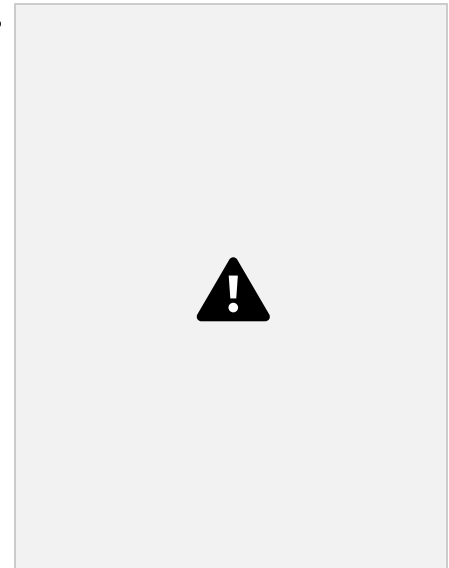
- postural sway in standing
- What happens in sitting?
- 90-90-90 posture requires energy



- Passive sitting saves energy but reduces alertness

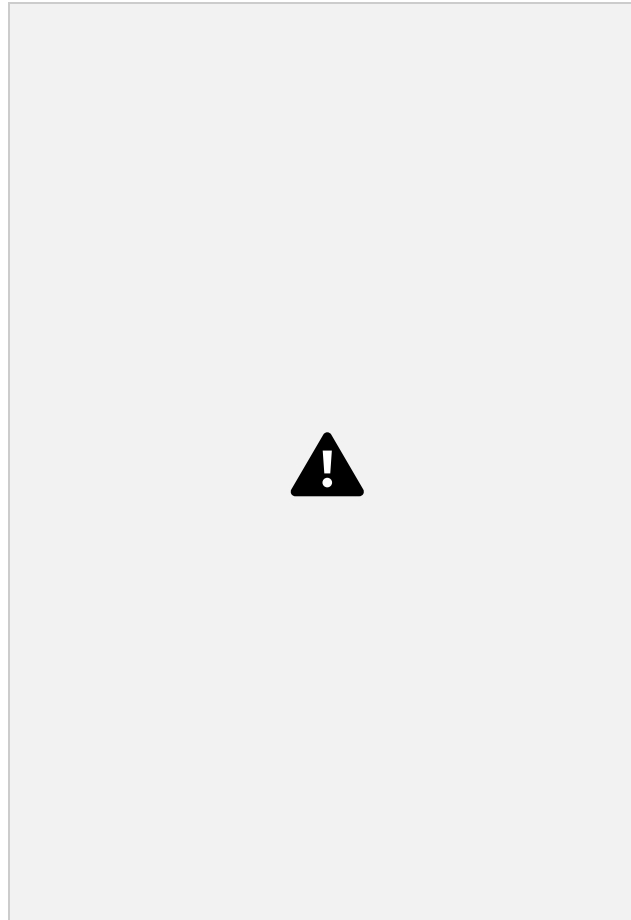
Comparison across populations • Lumbar support to reduce sitting pressure – 90% improvement for healthy adults

- No influence for SCI



Why do you think?

(Hobson & Tooms, 1992 ; Shields & Cook,1992)



From Engstrom "Ergonomic Seating"



From  
Engstrom "Ergonomic Seating"



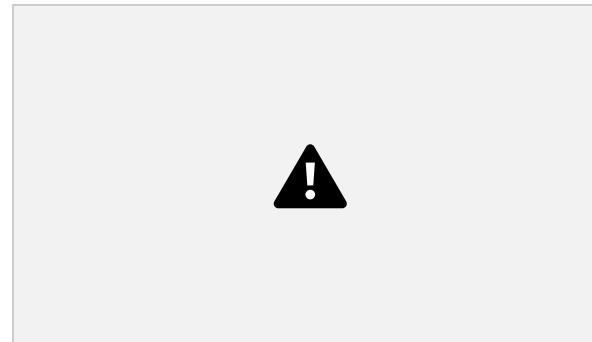
From Engstrom "Ergonomic Seating"

# Goals of seating

## 1. Function

– School needs?

## 2. Prevention



Different sitting for different functional

needs (for GMFCS III-V seating more  
challenging)



Personal Posture

- Realistic
- Individualized
- Support points
- Prevention
  - Contractures
  - Pressure sores

(Minkel, 2000)

# Sitting ability





- Hands Free
- Hands  
Dependent
- Prop Sitting



- How does this help us?

## Level of Seating Support (LSS)

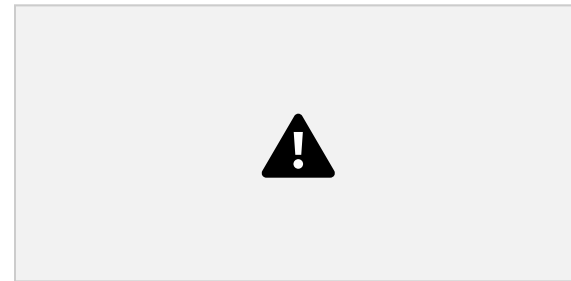


Principles

Goals: function and prevention

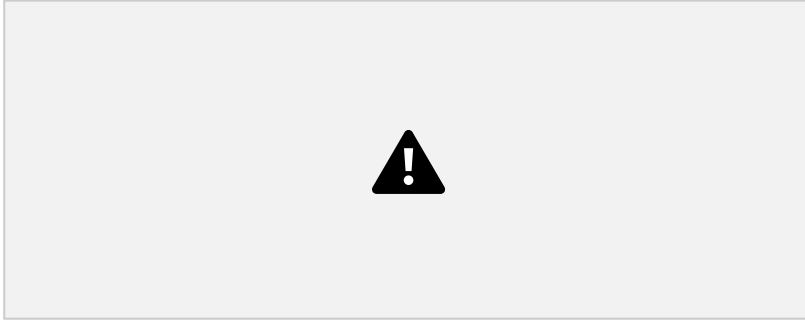
Principles:

1. Stable base
2. Posture



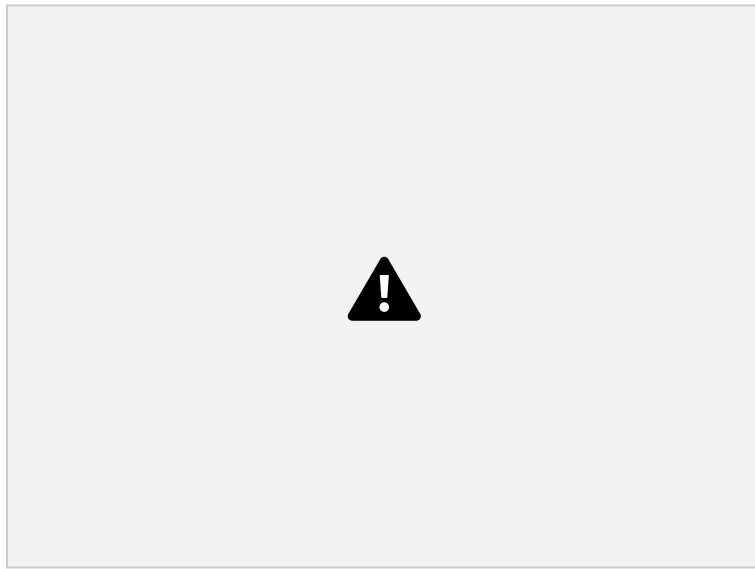
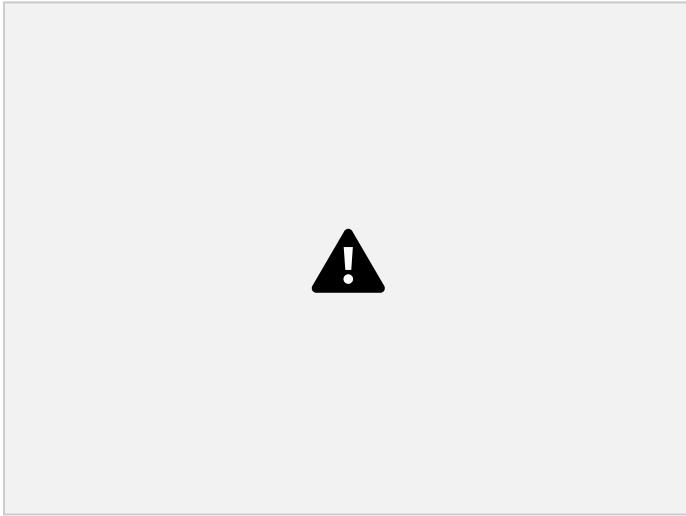
## Stable base

- Pelvic tilt and position
- Pelvis lower than thighs
- Emersion/friction vs movement
- Loading greater trochanters



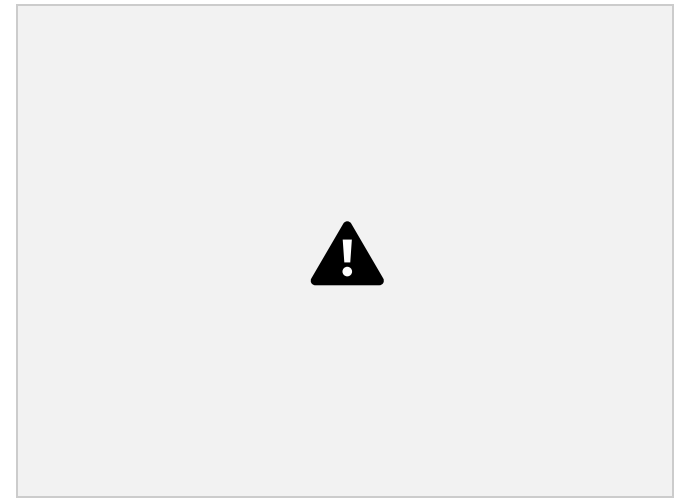
WSTP basic reference manual

# Stable base

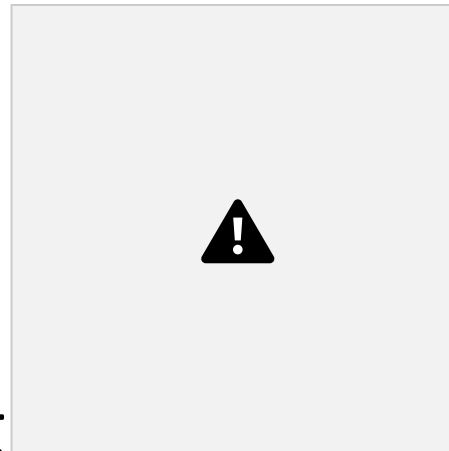


Stable base

- Snug pelvis belt
- Position of belt

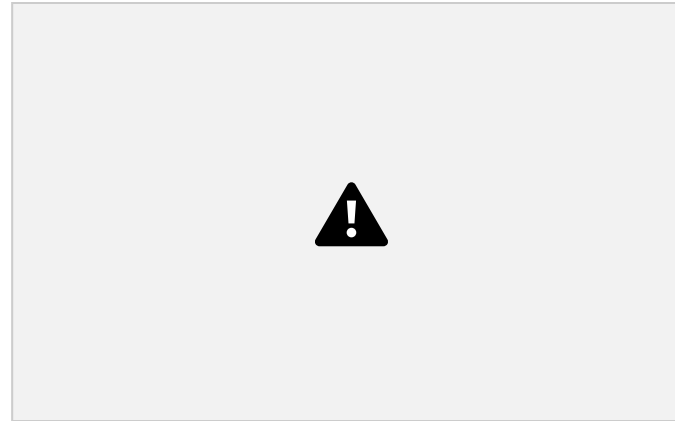
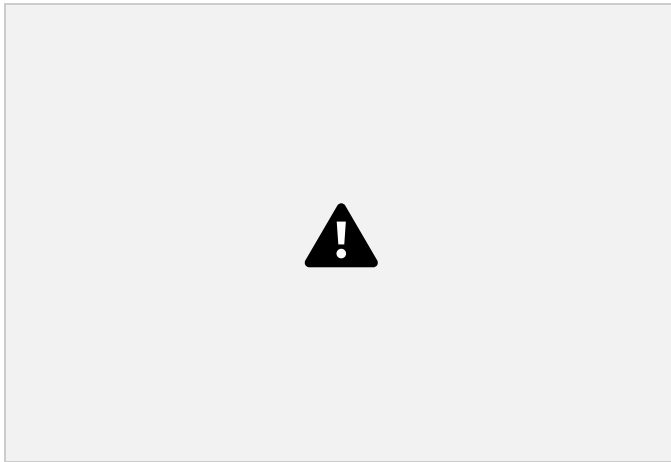
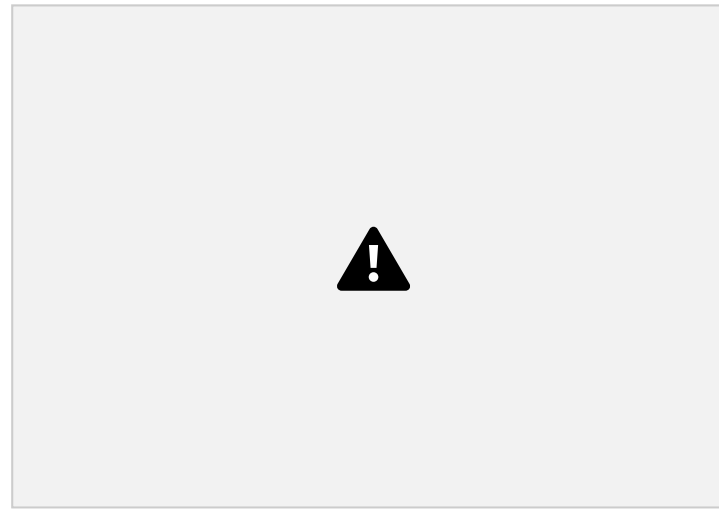
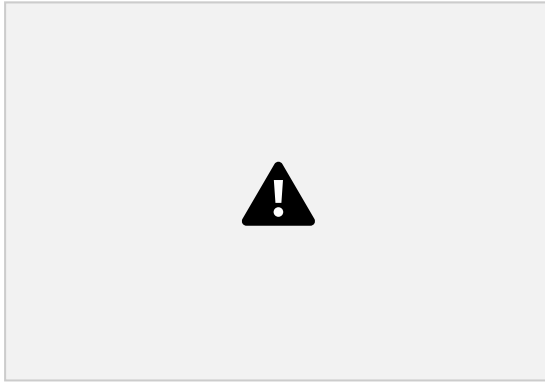


- Common problem: Belt rising over iliac



crest submarining

# Pelvic positioning belt

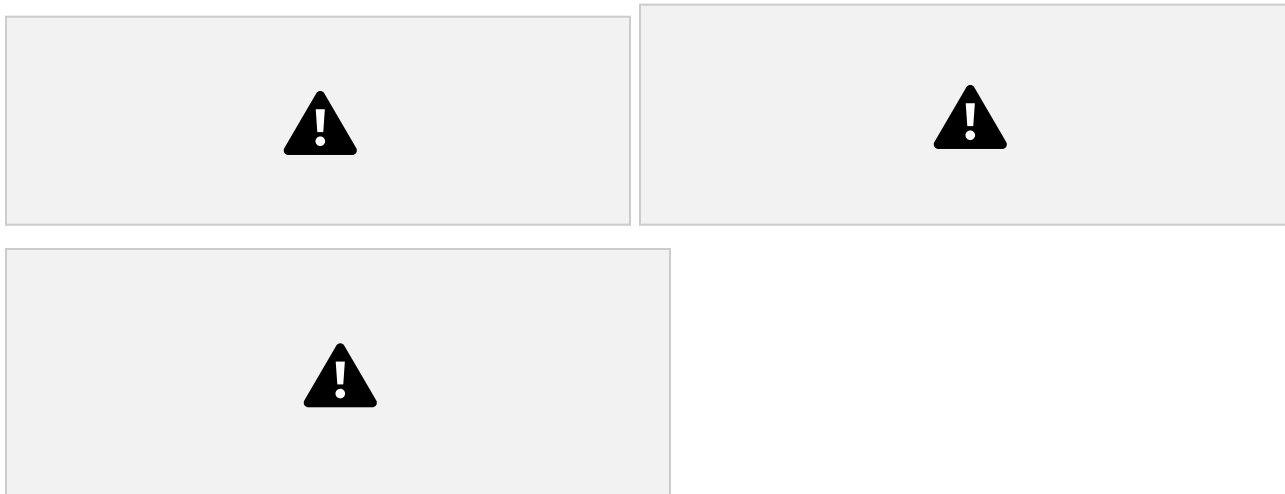


[http://www.bodypoint.com/data/default/assets/public/BM044%20Pelvic%20Support%20Users%20Guide\\_low.pdf](http://www.bodypoint.com/data/default/assets/public/BM044%20Pelvic%20Support%20Users%20Guide_low.pdf)

# Pelvic positioning belts

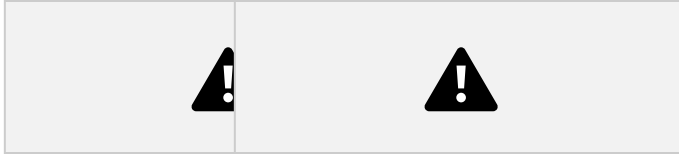
## 4 point belts

- Main belt and anchor
- Prevent main belt
  - Rising
  - Slipping





# Positioning belts



45<sup>0</sup>

Like car belt

Loads IT

Reduces pelvic movement (gives stability)

0<sup>0</sup>

Prevents forward reach Increases PPT

Encourages PPT

Reduces APT

Does not prevent sliding forward



90<sup>0</sup>

Prevents raising pelvis  
if combined with antithrust cushion Prevents

PPT allows

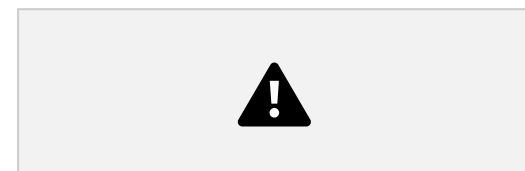
forward reach

Helps PPT and Obliquity

Best with anchor ( 4 point)

Needs anchor to prevent

submarining  
Good for  
APT



60<sup>0</sup>

Proximity to GT gives stability  
Less pelvic motion  
Loads femur not IT  
Allows forward reach

Reduces PPT together with cushion with  
antithrust  
t Help  
obliquity

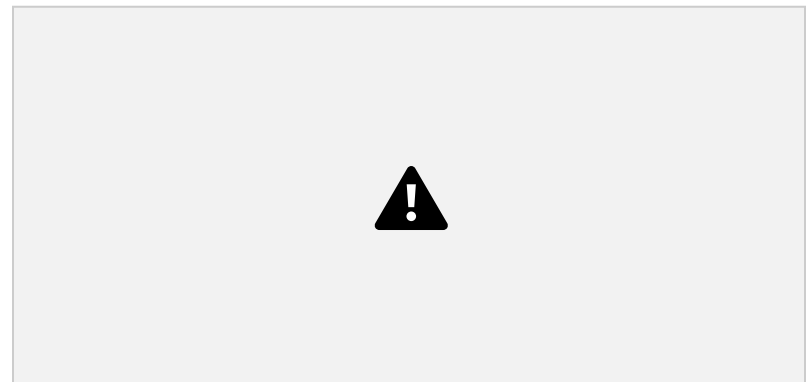
## Stable base

- Ideal positioning is  $60^{\circ}$ - $90^{\circ}$  (Chaves et al., 2007) •
- Study on 20 children CP + TBI Cimolin et al., 2013 •
- 70% belt helped
- Which position?
  - 57% : 4 point at 90 + 60
  - 21%: 2 point at 60
  - 21%: position not important



# Posture

- $100^{\circ}$  (even  $110^{\circ}$ ) at pelvis
- $90^{\circ}$  knees and ankles
- Depression for pelvis
- Slight anterior pelvic tilt
- $3^{\circ}$ - $5^{\circ}$  tilt in space (permanent)



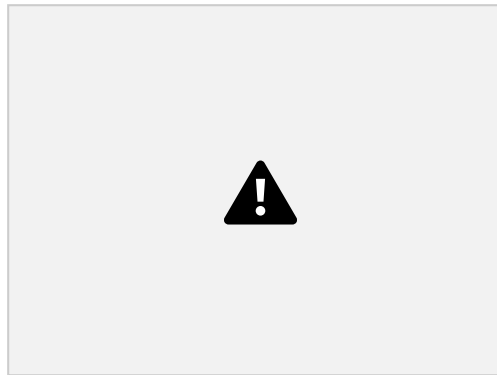
# Posture

## מחלוקת 90-90-90

### Pro

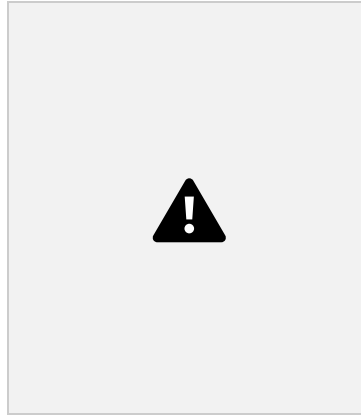
- Ergonomic
- Symmetric
- Lowers muscle tone (not studied over time Nwaobi 1993;Kangas 2000)

- Better hand function



### Con

- Requires energy
- Might reduce hand function (Engstom, 2004)
- Requires a lot of support (Minkel, 2000)
- Not appropriate for
  - Paraplegics
  - quadriplegics



- Anterior
  - Encourages hand function

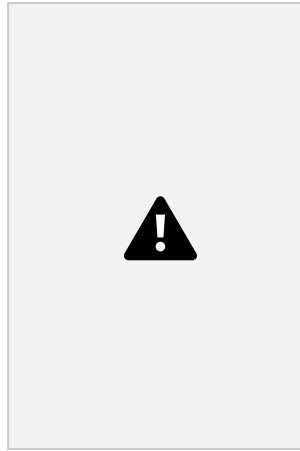
## Posture

## Tilt?

- Posterior:
  - Higher tone and pathological movement
  - Encourages trunk ext. – Slight for Hemiplegics for leg

propulsion

– Ant. Tilt with  
contour cushion  
(Engstom )



– Prevents pelvis slipping –  
Might help pelvis position

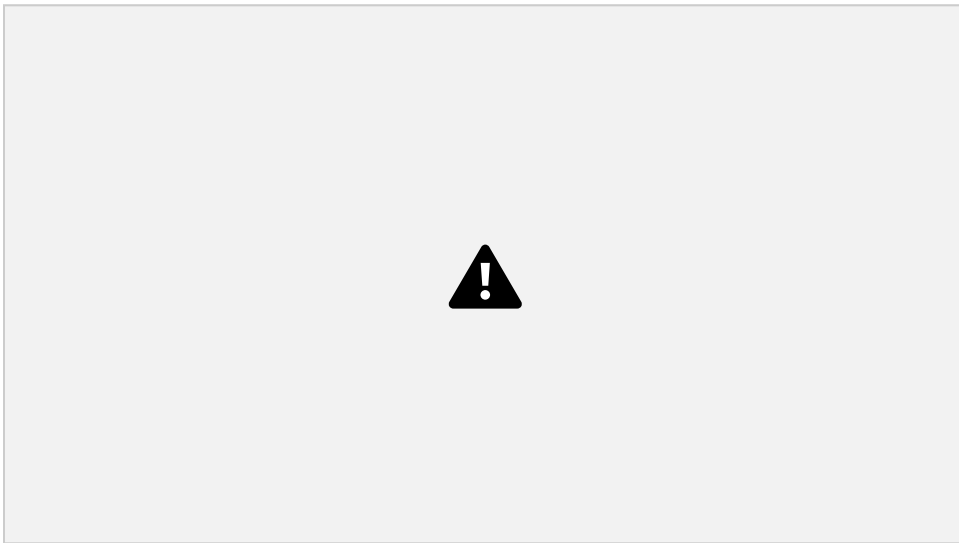




Dynamic seating



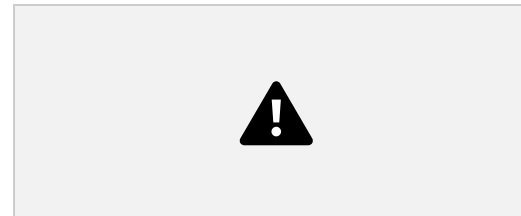
- Children with dystonic movements •  
Allows movement then passively returns to  
place (vs restraint)



Assessments

# Understand abilities and challenges Outcome measure

1. Ilanot Assessment
2. SPCM/A + SPS
3. WSTP
4. WhOM-YP
5. Pressure mapping



<https://sralab.org/rehabilitation-measures>

## Seating assessment

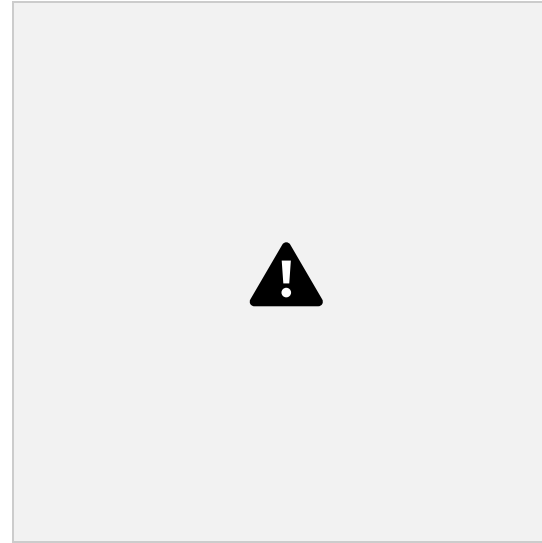
- Description of seating pre-intervention
- Functional goals
- Physical assessment – ROM
- Skin check
- Sitting control
- Trial seating / supports needed
- Measurements prescription
- Finance, maintenance

## Description of sitting

Position: fixed / flexible till neutral / flexible part

# way to neutral

- Pelvis ASIS +PSIS
- Back
- Head
- legs





# Seating Postural Control

## Measure: SPCM

– multiple choice postural description

- Hand function / seating
- LSS

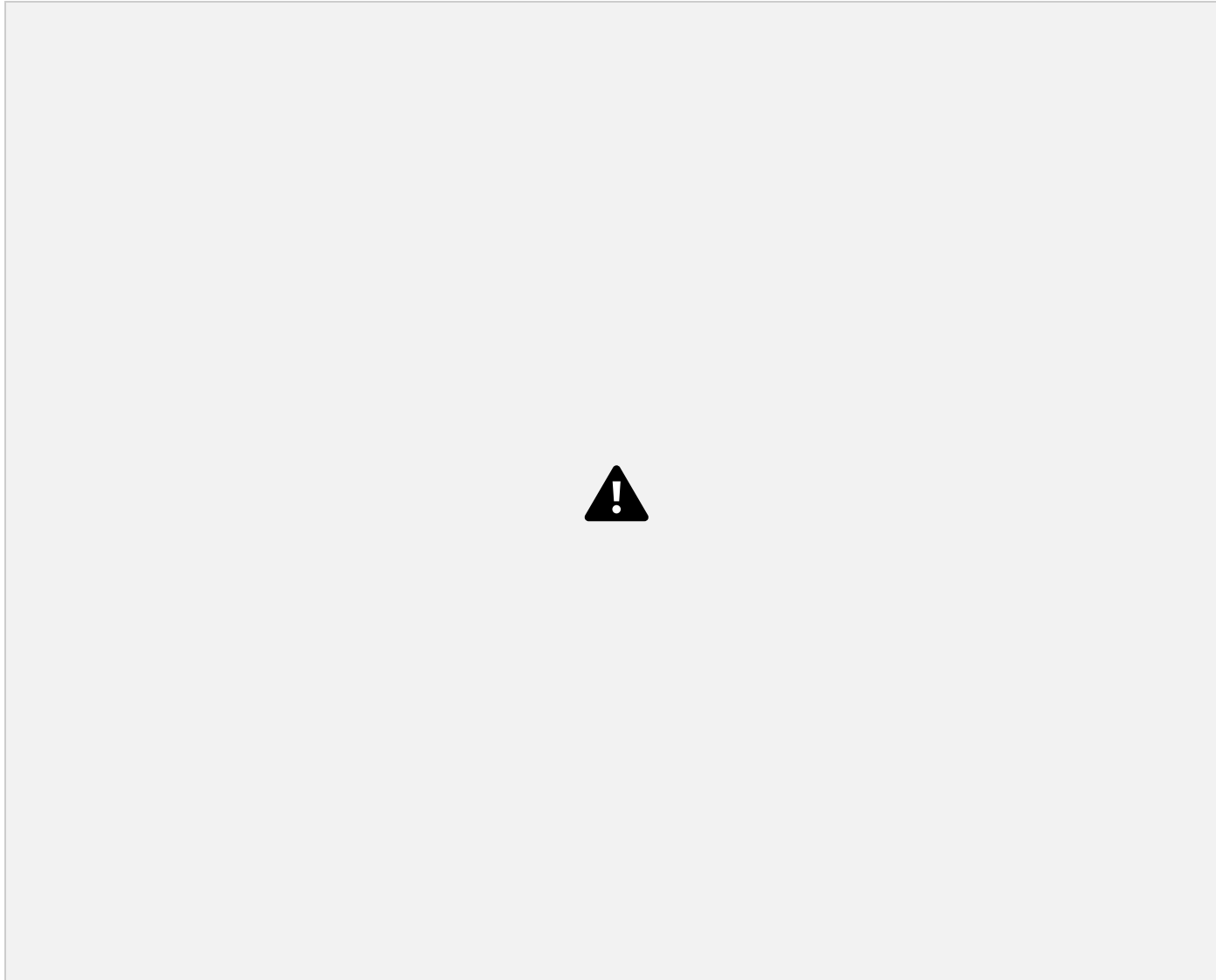


## SPCM-A

(Gagnon, Vincent & Noreau, 2005)



# Seated Posture Scale



# Wheelchair Service Training



# Package

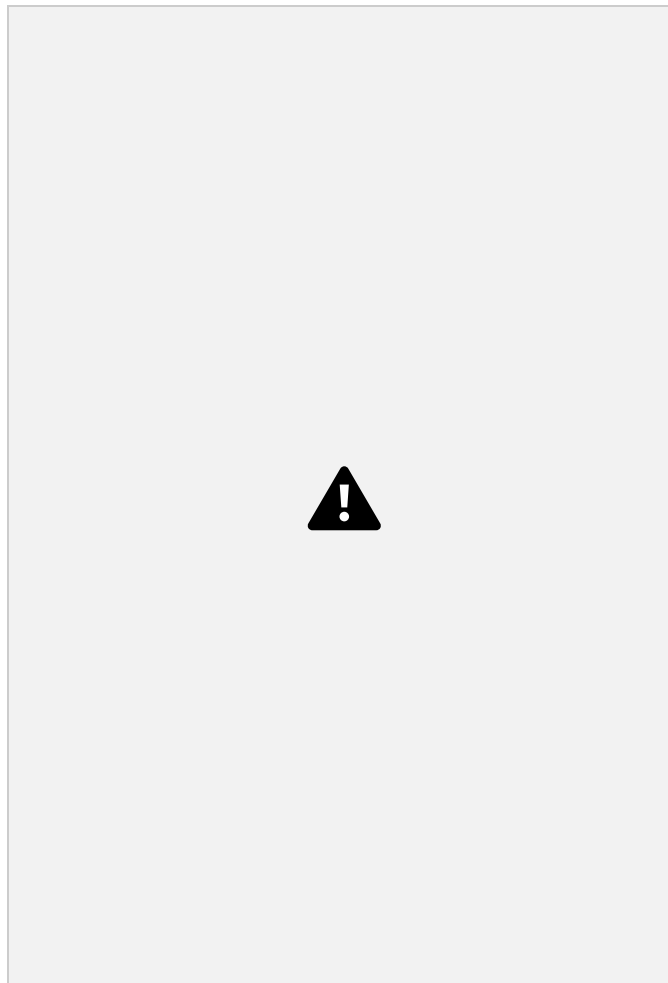
- Stick-man for postural description •

Physical examination on bed

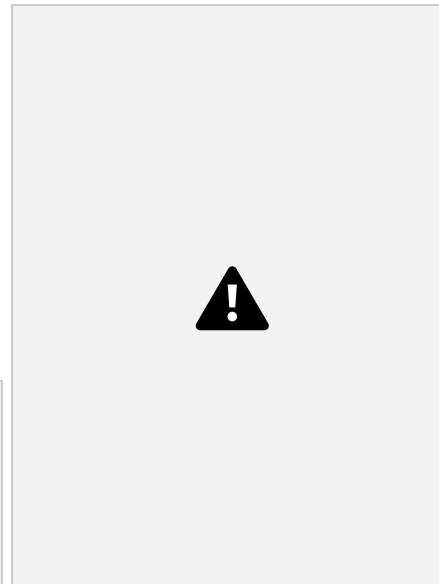
- Simulation of seating
- WC prescription + training +
- maintenance + follow up



Mat



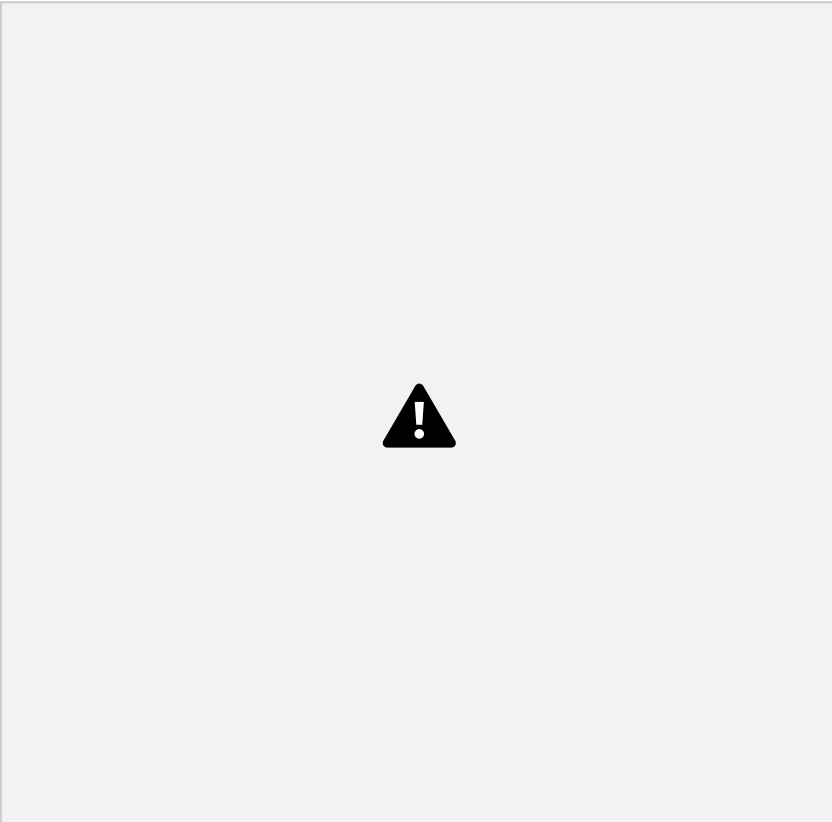
test





Pelvic obliquity

# Mat test



left right



WSTP

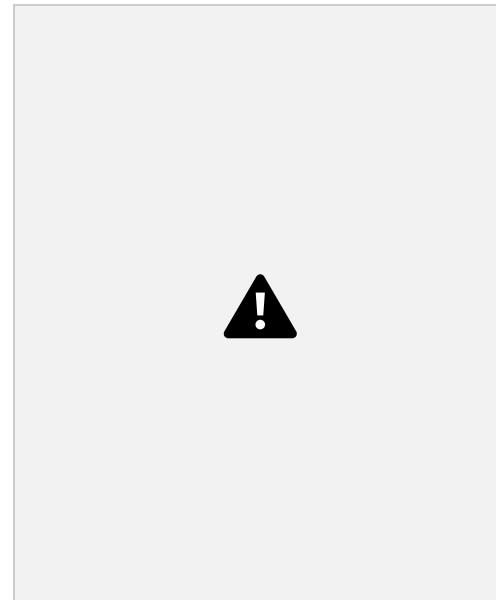


# Pressure Mapping

- Objective measure
- Questions about reliability
  - over times
  - Between people
- Measures P between person and cushion – Expensive, not assessable in clinics – Good to teach pressure relief

## Other options

- Function In Siting Test



(FIST) Not pediatric

14 tasks in sitting

<https://www.sralab.org/rehabilitation-measures/function-sitting-test>

- Trunk Impairment Scale (TIS) Static and dynamic sitting balance

<https://www.sralab.org/rehabilitation-measures/trunk-impairment-scale>

## Universal terminology

A clinical application guide to standardized wheelchair seating measures of the body and seating support surface

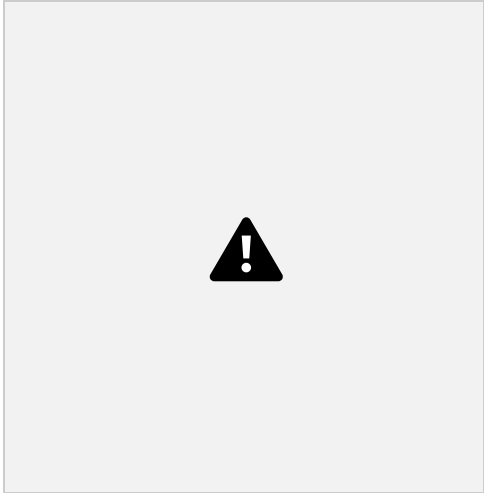
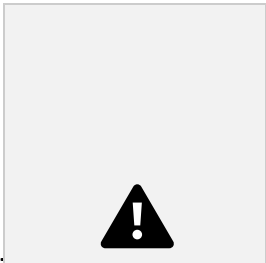


<https://www.ncart.us/uploads/userfiles/files/GuidetoSeatingMeasuresRevisedEdition.November2013.pdf>

# Pelvis

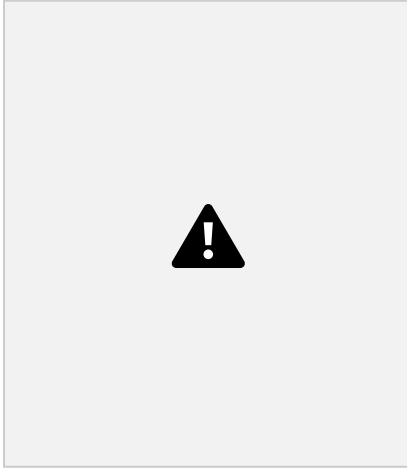
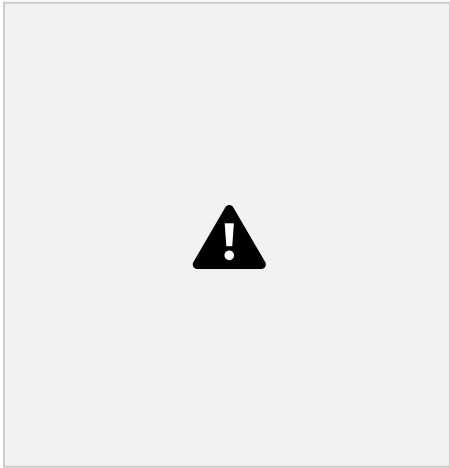
WSTP  
Intermediate  
Level  
Participant's  
workbook



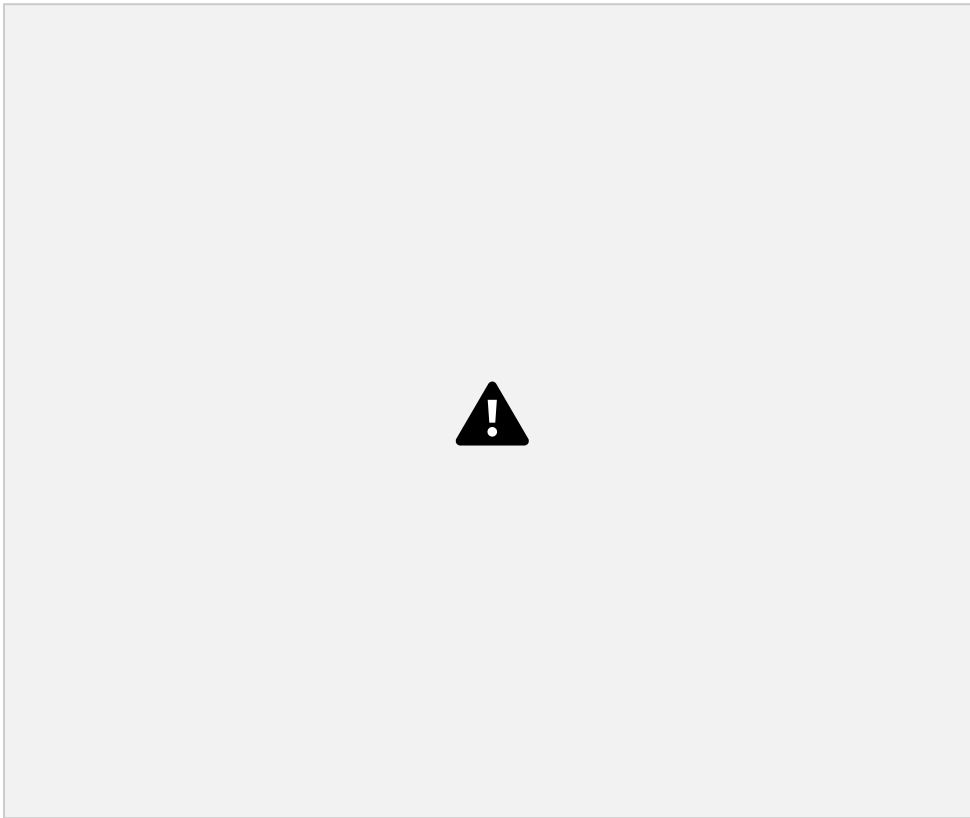
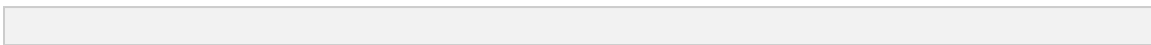


WSTP  
Intermediate  
Level  
Participant's

workbook







# Common problem

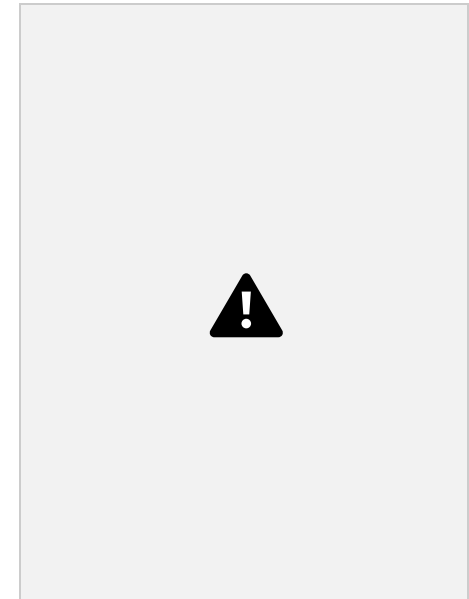
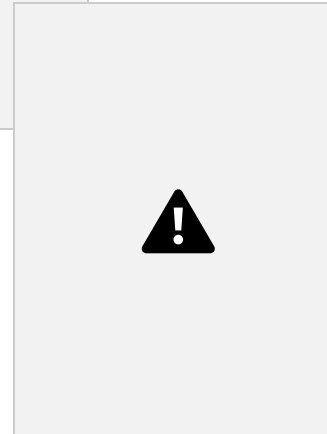
(GMFCS I-III)

What problem  
do you see?

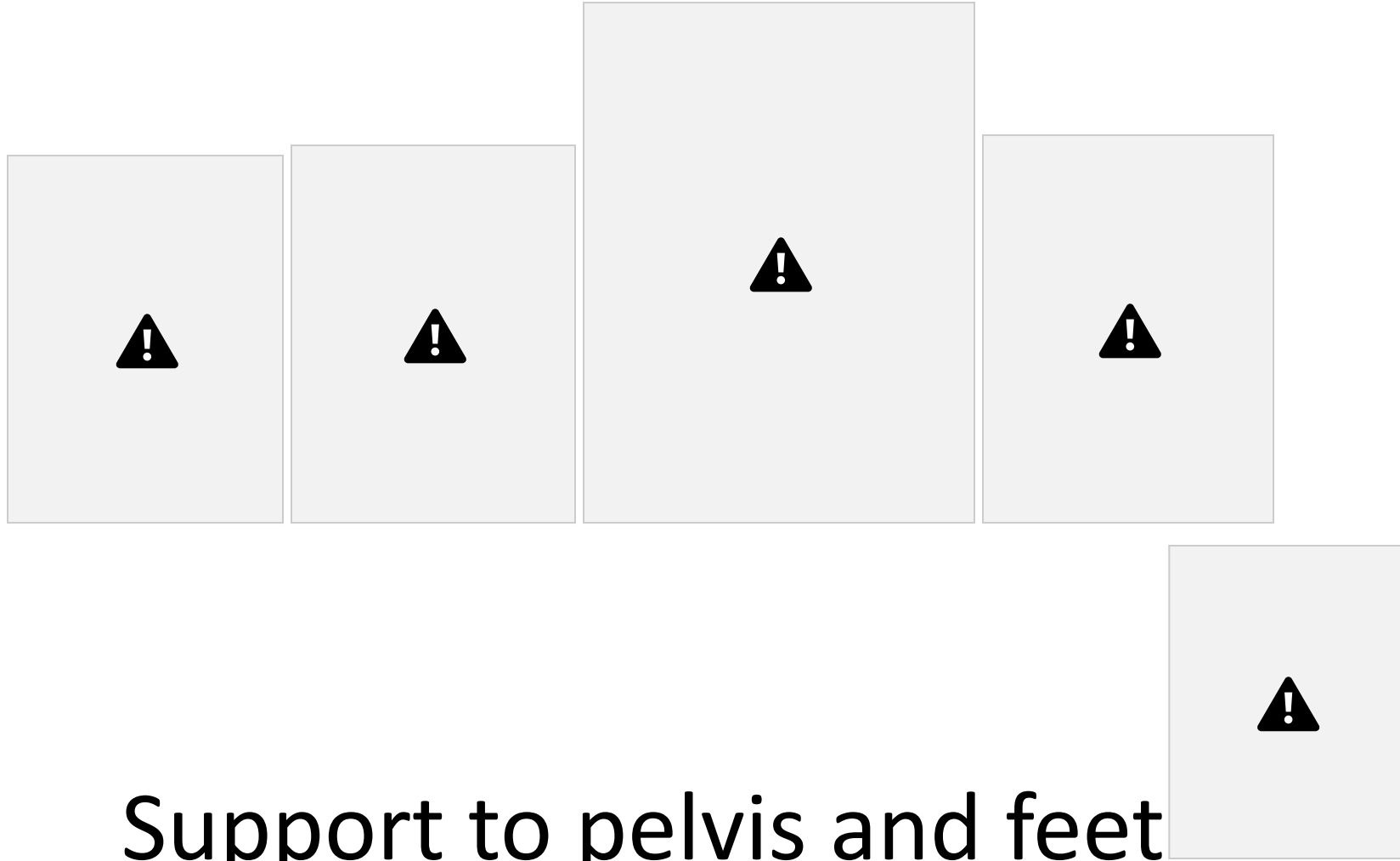
Why?

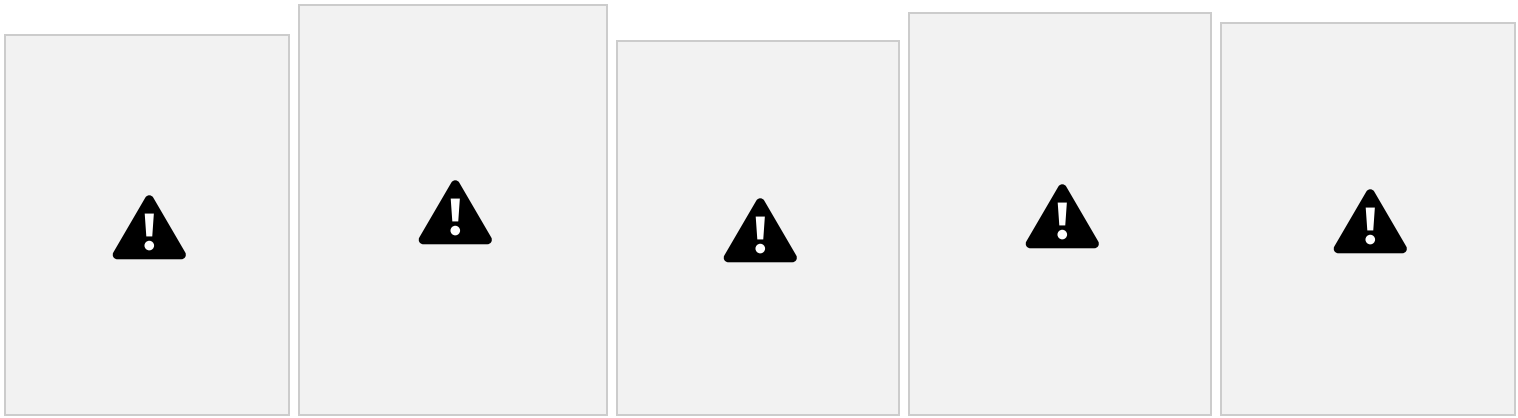
- PPT
- Causing flexion in trunk
- Chair too deep
- Feet unsupported

## Solutions



why?





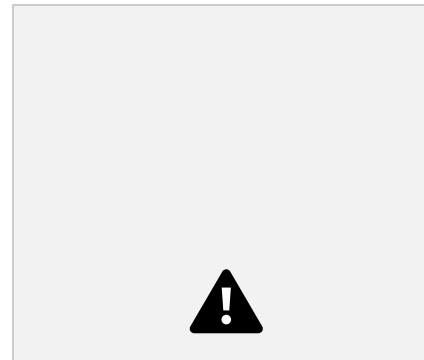
## Pelvis: PPT

### Due to chair

- Too deep
- Too high (footrests low)
- Slippery cushion

### Due to person

- **Flexible or Fixed?**



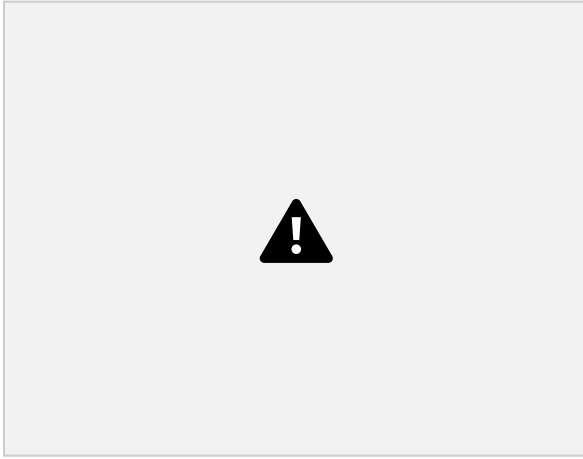
- Muscle tone high or low
- Lack of awareness
- Stability

## PPT

- Fix chair dimensions • Pelvis lower than thighs • Cushion +  $90^{\circ}$  or  $60^{\circ}$  belt • Support PSIS
- Slight tilt

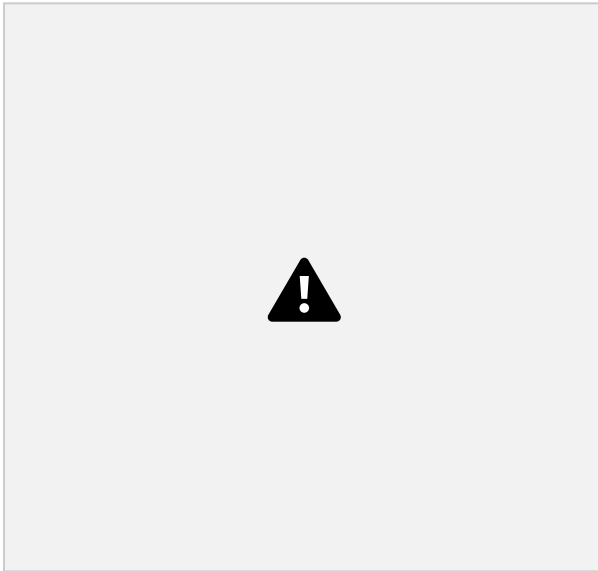






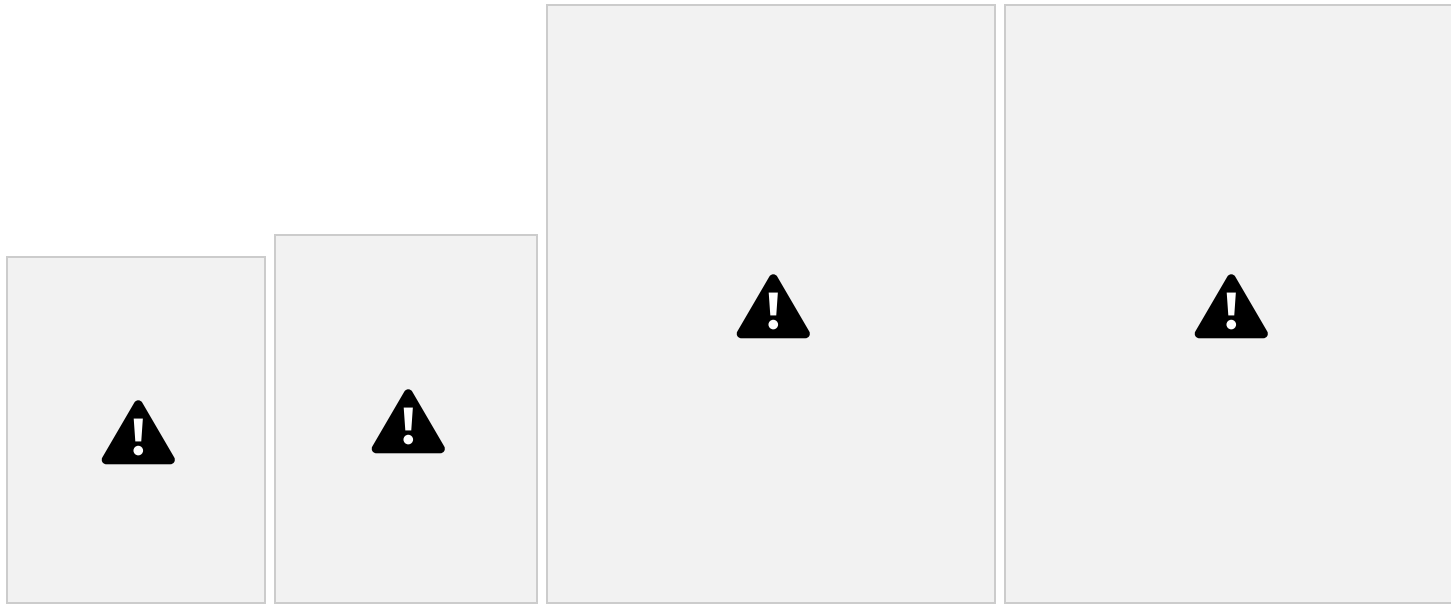
PSIS

# Ergonomic chair



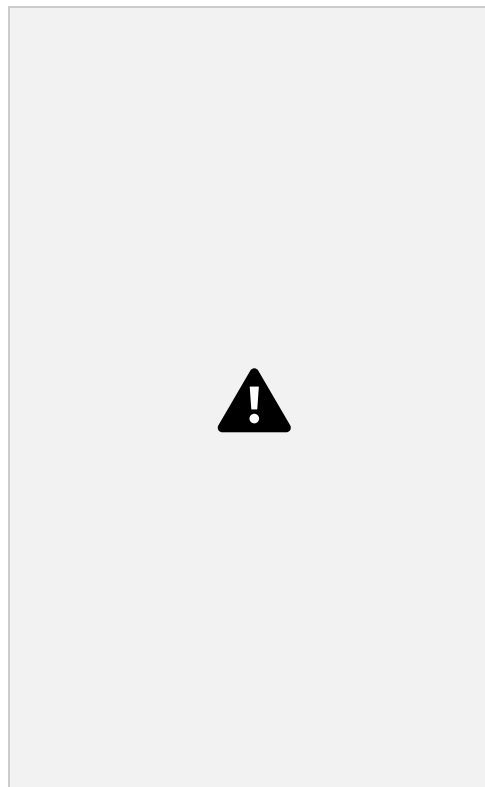


Ergonomic chair with adaptations



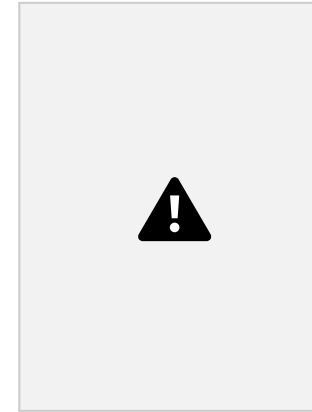
## Pelvis : APT

- Flexible or fixed?
- Belt on ASIS
- $45^0$  or  $0^0$  (4 point)



- table
- Wedge
- Leg rest

- Extreme: tilt (see lordosis)

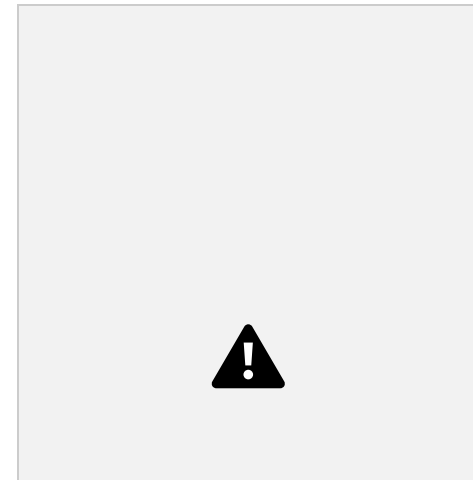


## Rotation

Internal factors:

- Muscle tone
- Contracture of one side of

hip External factors:



- Leg rest discrepancy
- positioned asymmetrically – Back not

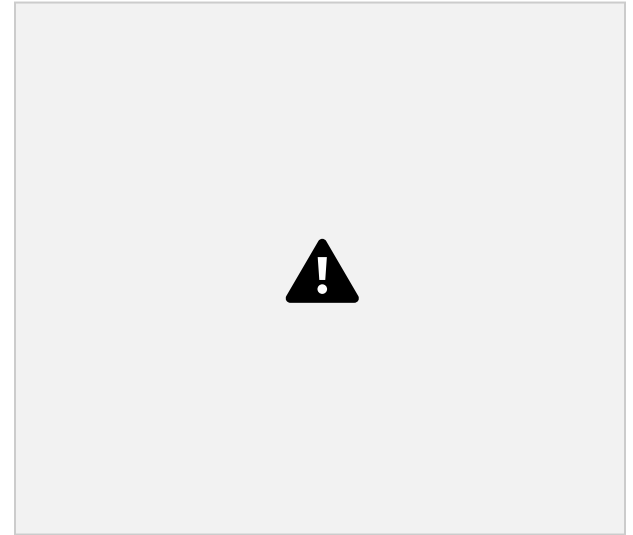


## Pelvic rotation

(more likely at GMFCS III+)

- Fix chair
- Flexible or fixed?
- 4 point belt  $0^0$  (anchor at 45)

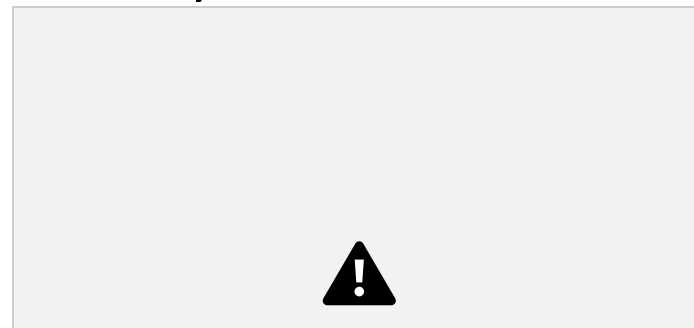
- Adjust cushion for hip contracture



## Pelvis Obliquity (lateral tilt)

Internal factors:

- Muscle tone (pelvis or trunk)
- Pain
- Contracture



## External factor:

- Asymmetrical seat

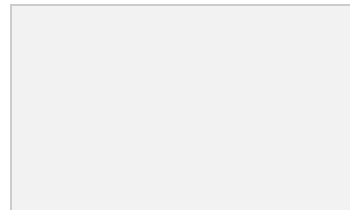


## Pelvis Obliquity (lateral tilt)

### Flexible:

- Belt  $90^{\circ}$  with 2ndary at  $45^{\circ}$
- Addition to lower side of pelvis (temporary)

### Non-flexible (fixed):



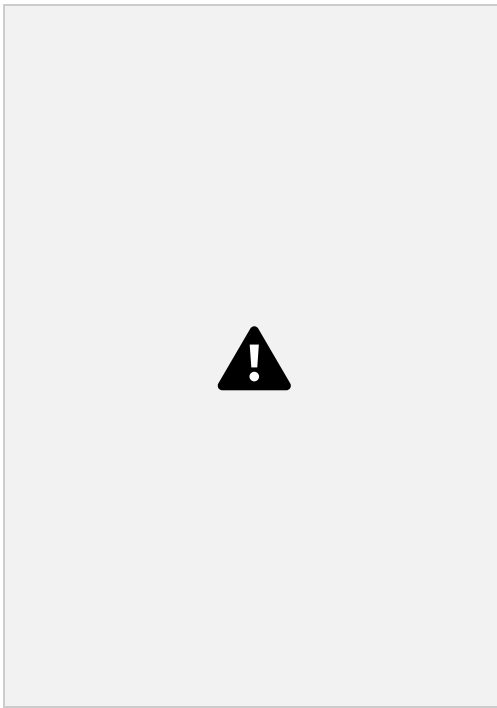
- Belt
- Addition to **higher** side of pelvis
- Support Greater Trochanter

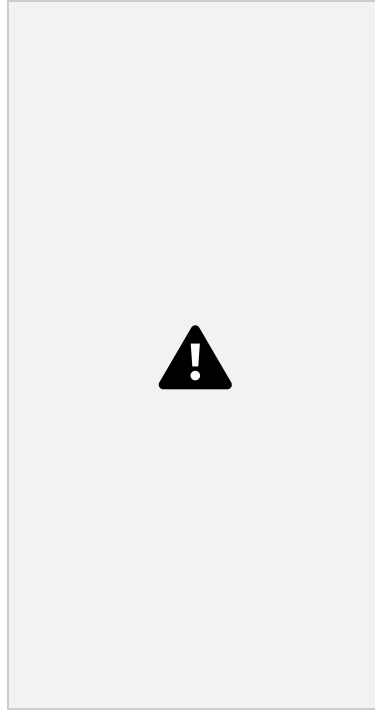


# Pelvis lateral shift









Trunk

1. kyphosis
2. lordosis
3. Scoliosis  
– “C”

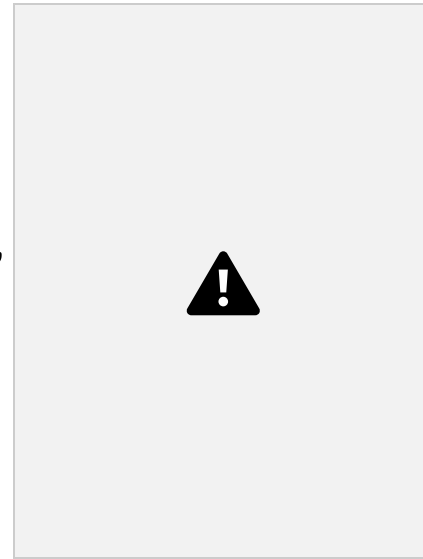


– “S”

Problems: hand function, speech,  
breathing, eating....

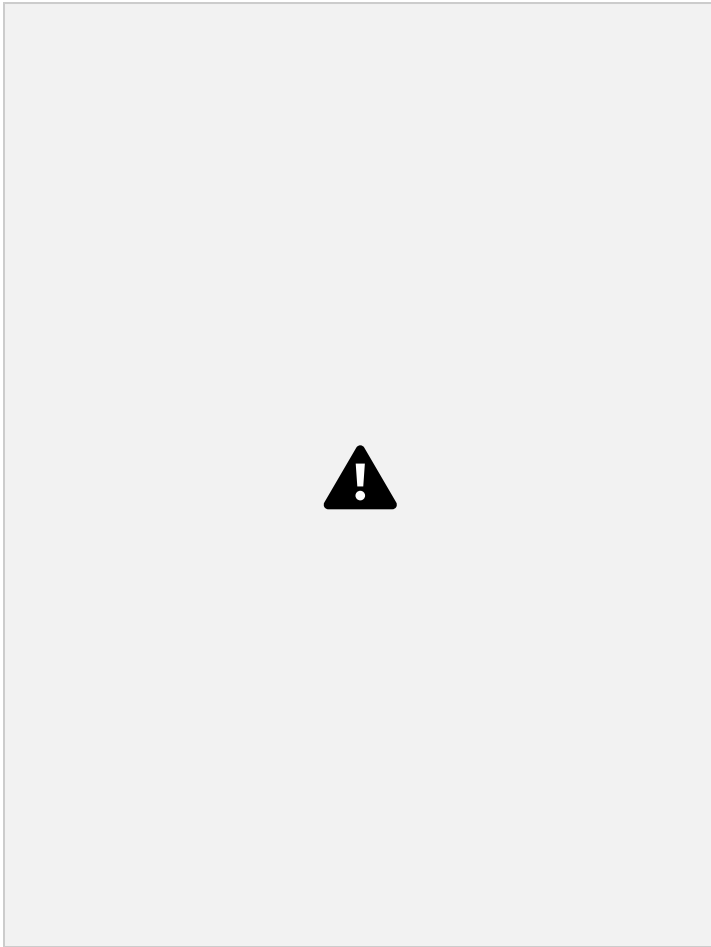
## Solitons apart from seating • spine fusion

- Corset (soft or firm)
- Back belt
- (seating system or “insert”)



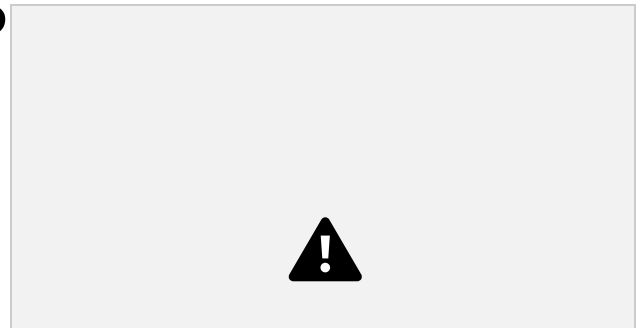


What is the problem? What can we do?



# Kyphosis

1. The chair



- Too deep
- Too reclined
- Back hammocking

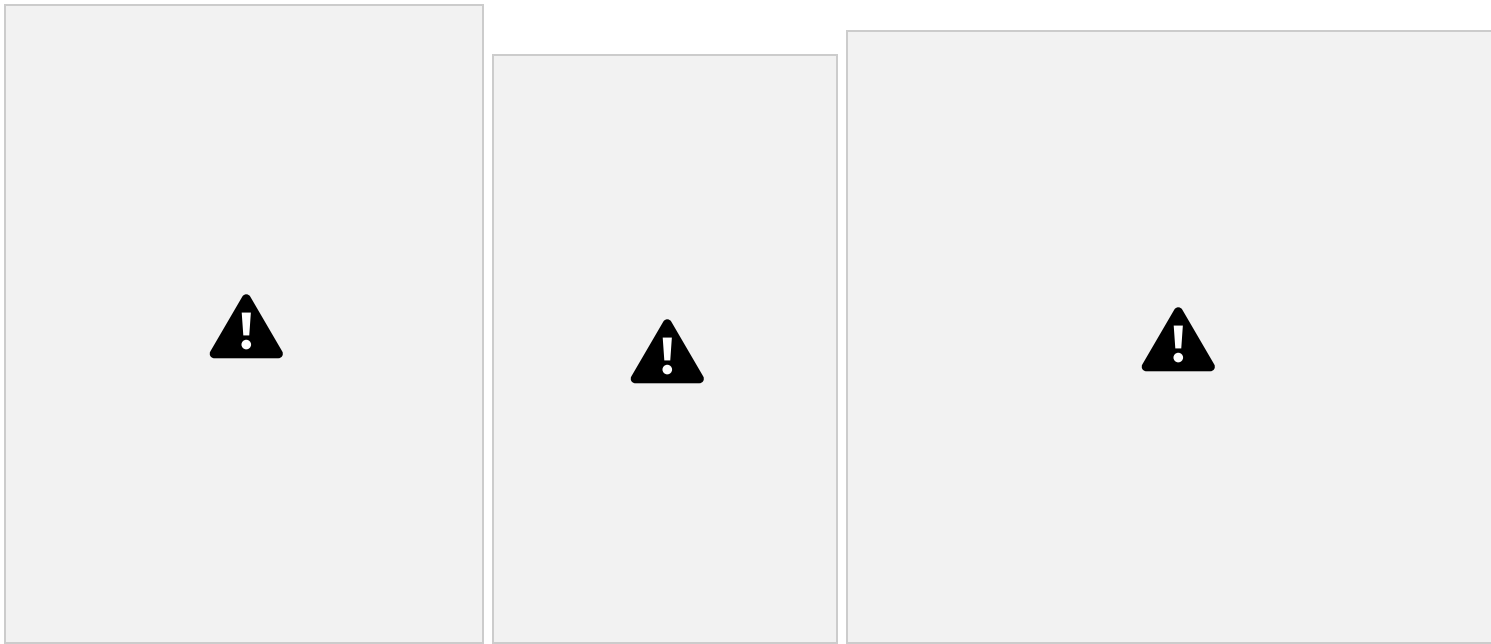
## 2. The person

- Deal with PPT (PSIS support)
- Strap backrest adjustments
- Tilt (fixed or adjustable)
- Recline (fixed or adjustable)



invacare matrix clinical seating & positioning guide, 2013

# kyphosis



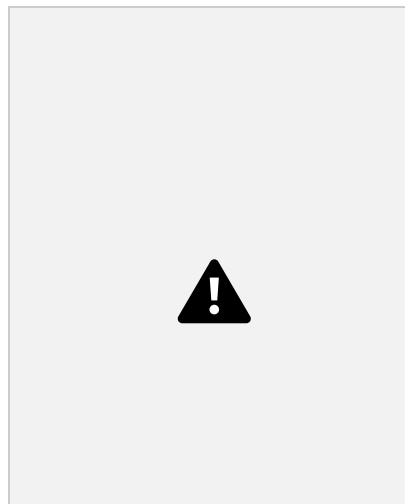
Engstom (2004); Levitt (2004);Pope (2002);  
Trefler & Taylor(1991)

## Lordosis

Often from

APT (ASIS

support, wedge...)



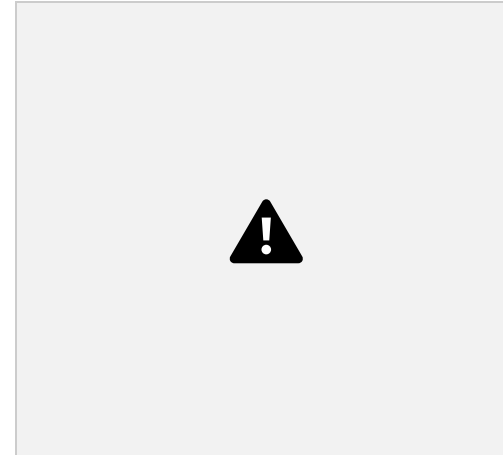


# Hamstring tightening

+/- muscle tone

## Solutions:

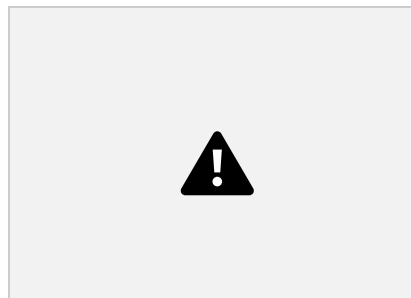
- Abdomen / shoulder strap
- Strap back adjustments
- Tilt (fixed or adjustable)
- Recline (fixed or adjustable) – Cushion fill for back



# Scoliosis

Internal factors

- Lateral pelvic



tilt

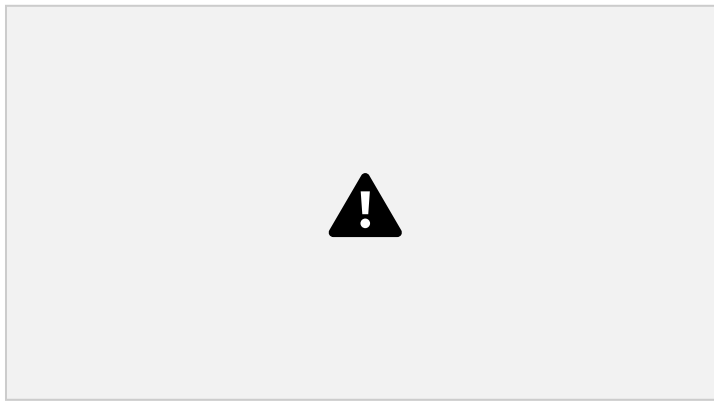
- Muscle tone asymmetry
- ideopathic
- weakness

## External factors

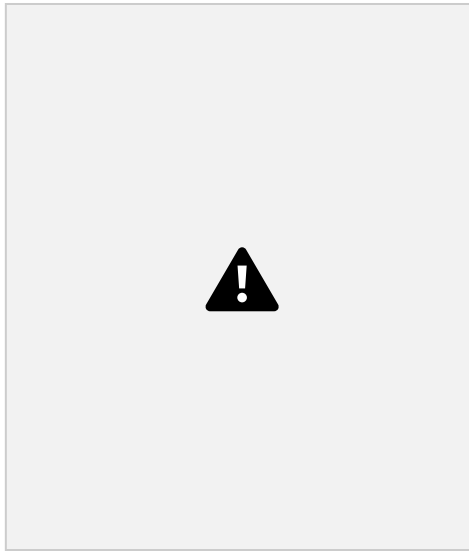
- Chair too wide
- 1 handed manual wheelchair

## Scoliosis

- Deal with pelvis
  - Fix chair
  - Lateral trunk supports
- (3) • Contour backrest
- Back with straps
  - Tilt (fixed or adjustable)



Holmes



et al (2003)

(be cautious with recline as lat. supports will rise)

# Danger in lateral trunk supports



# Head supports

