

# Posture, How it Develops, and The Reason We Sit

## Posture

Human posture can be defined as, “*the position of one or many body segments in relation to one another and their orientation in space*” (Ham et al, p26). The head, trunk, pelvis, lower limbs and feet are known as body ‘segments’, while spinal joints, hips, knees, ankle and shoulder joints are considered the body ‘linkages’ (Pope 2002).

Human posture is influenced by a number of interconnected factors:

- muscle tone (i.e. high or low)
- body shape and size (i.e. height and weight)
- gravity
- the surface (e.g. uneven ground, slopes, sand, footwear)
- the task in hand
- length of time required to be in a particular posture
- level of health, well-being or emotional state

Therefore, posture can be seen as the inter-relation and inter-dependency between:

- comfort
- stability
- function (including movement)

In the absence of stability, function (for example, the ability to play, use communication devices or do schoolwork) is impaired. However, stability can only be achieved with some degree of comfort. Function may be achieved in the absence of comfort or with minimal stability, but it will be short-lived. The balance must be struck between comfort, stability and function, depending on the task in hand and the environment. Therefore posture is important because it supports a vast range of daily functions, in addition to supporting internal processes such as breathing, vision, digestion, circulation, temperature regulation.

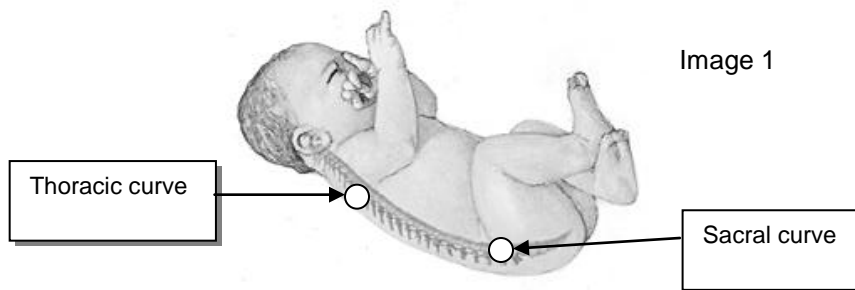
Humans need to be able to operate in a variety of environments, for a variety of reasons and hold themselves upright against gravity. When considering posture it should be seen as an active and dynamic process which underpins movement and function (Hong, 2005). Howe and Oldham (2001) also highlight that posture and movement are inextricably linked, referring to posture as a temporary arrested movement, which is in a constant state of change.



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## How posture develops

When babies are born they have a predominantly flexed (C-shaped) posture with two primary spinal curves known as the thoracic curve (mid back) and sacral curve (bottom) (see Image 1).



In the usual sequence of events, babies move through developmental stages almost seamlessly (Image 2).

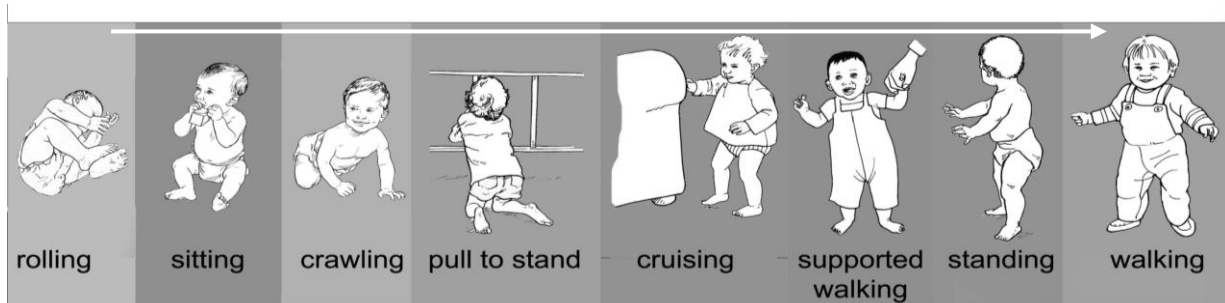
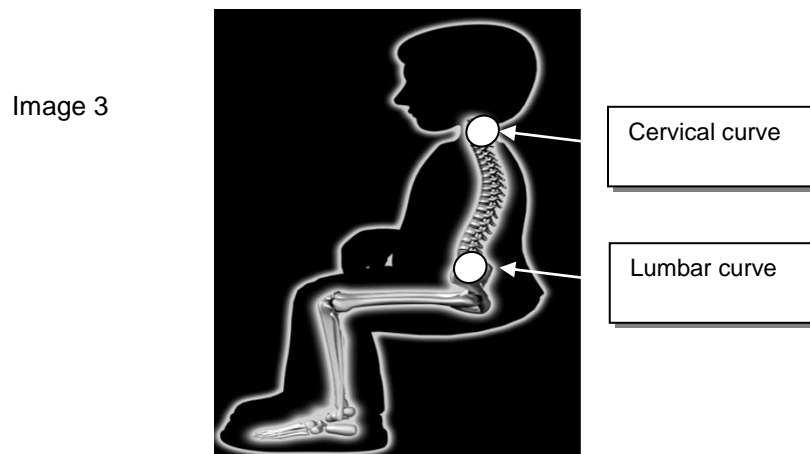


Image 2

As they learn postural control against gravity their spines develop secondary extension curves in the cervical (neck) region first (holding their heads up against gravity when on their tummy or hands and knees) and lumbar region (lower back) as they gain sitting and standing balance (Image 3).



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Postural control requires achieving normal developmental milestones and includes the maturing of postural reactions (righting, protective and equilibrium reactions), the integration of primitive reflexes (asymmetrical tonic neck reflex, symmetrical tonic neck reflex, tonic labyrinthine reflex), as well as normal muscle tone, normal postural tone and intentional voluntary movements (Wandel 2000).

## The reason we sit

Children usually develop sitting posture between six and nine months. Achieving sitting posture requires the development of postural control of head, trunk and upper limbs against the pull of gravitational forces (Wandel, 2000). This enables the pelvis, trunk and shoulder girdle to remain stable so that the hands are free for function – clinicians commonly use this principle of achieving pelvic stabilisation to maximise control for hand function when prescribing special seating.

The sitting position is more relaxing than the standing posture, provides a greater support surface and allows relaxation of the muscles in the legs (Howe and Oldham, 2001).

When children's development is delayed, independent standing or walking may not be achievable, and the use of equipment for standing and walking tends to be relatively short in duration. Therefore the most commonly used upright posture is the seated posture. Sitting thus becomes an important posture socially as most people interact in an upright position. Perceptually too, an upright posture helps develop three dimensional depth and distance awareness. It's easier to make sense of the world around us when our head, eyes and ears are upright.

However, there is greater potential for pelvic instability in sitting compared to standing due to the hip joint position, the anatomical shape of the ischial tuberosities (Reid and Rigby, 1996) and the tendency for the pelvis to rotate backwards (Engström, 2002).

If children have not developed sitting skills by their developmentally appropriate age, it is considered important for them to be placed in this position at the earliest opportunity for all of these reasons. A recent consensus statement on 24 hour postural management recommended that the most severely affected children should be introduced to special seating at six months of age (Gericke et al, 2006).

## Sitting and research

Clinicians are expected to support their clinical decision-making using a process of evidence based practice. The highest level of research evidence is the double blinded randomized control trial (RCT) commonly used in drug trials. This is when neither participants nor researchers are aware of who belongs to the experimental group and who belongs to the control group.



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It is considered “gold-standard” level because it removes many of the confounding variables which can be found in other research methodologies, therefore reducing the likelihood of the outcome being down to chance.

However, when we think of children with disabilities and special seating systems, it is neither practical nor ethical to take this sort of approach. It would not be possible to prevent children, therapists and researchers from knowing who was using a special seat and who was not (it would be obvious), nor is it ethical to withhold treatment (as would be necessary for a control group) when there is no evidence that special seating is *not* beneficial.

Therefore researchers have no choice but to use alternative study designs, which although may be perceived as less rigorous in research terms, are more suited to the complex variables which affect individuals with disabilities. For example, a group of 10 year old children with Cerebral Palsy Spastic Quadriplegia will not present clinically in exactly the same way. In addition there are many other extraneous factors which cannot be controlled for by researchers - such as social circumstances or other medical issues. As a result, researchers invariably have small sample numbers, or use case series or single case study designs. This does not reduce the value of the research, and in terms of evidence based practice, clinicians must use the *best available* evidence to them. Expecting research with this population of clients to be a gold-standard RCT is asking the impossible.

## Evidence Based Clinical Need for Special Seating Systems

For children and young people with mild to moderate physical disabilities including cerebral palsy, Down’s syndrome, the early stages of muscular dystrophy, developmental delay, and developmental co-ordination disorder, postural instability is common. When children are posturally unstable, they use excess energy to try to maintain their stability and balance. This can affect how they function as there is little energy left over to concentrate on fine motor tasks, schoolwork, or even just to listen.

For example, think of trying to write when standing up – a wide base of support is adopted (feet apart) and the writing hand is stabilised by locking the elbow against the body. The task is achievable, but more energy than necessary is used up, and repeating the task becomes more difficult. The quality of writing is affected, and will further deteriorate as time goes on. If sitting down with feet and elbows supported, head and eyes are steadier, hands can freely move, and the quality and quantity of written work (function) improves.

It is exactly the same principle with everyday fine motor/concentration tasks for children with postural instability.



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When children and young people with moderate to severe physical disabilities such as cerebral palsy, spina bifida, muscular dystrophy, developmental delay, or acquired injuries fail to develop age-appropriate postural control, special seating systems or wheelchairs are prescribed (Pain, 2000).

Seating systems are aimed at providing an appropriate level of postural support for each user, as well as offering comfort, skin protection, and stability to enable daily functional activities to be carried out at home and at school (Johnson Taylor, 1993; Cutter, 1997; Perr, 1998; Hastings, 2000; Pain, 2000; Rappl, 2000; Buck, 2001; Paleg, 2006). In addition, the introduction of seating systems at an appropriate age is considered to facilitate psychosocial and cognitive development (Dworak, 2005).

The outcomes of poor postural management are well documented as increased dependency (Turner, 2001), tissue trauma (Turner, 2001; Gilinsky, 2006; McClinton, 2007), contractures and spasticity (Gilinsky, 2006; McClinton, 2007), poor systemic function, for example respiratory, cardiovascular and digestive functions (Turner, 2001; Gilinsky, 2006); immobility (Cutter, 1997; McClinton, 2007), increased pain and discomfort, and muscular fatigue (Cutter, 1997; Turner, 2001). As postural control is a pre-requisite for most functional tasks, the inability to control posture has a significant impact on function (Hong, 2002). A seating system that does not match the needs of the user is less likely to provide adequate postural support and may therefore limit function rather than promote it (Di Marco, 2003).

In addition, children and young people with physical disabilities are often placed in their seating systems for several hours per day (Janson, 2005) further increasing the importance of optimum postural support and positioning to prevent unnecessary dependency, skin breakdown, pain, fatigue, immobility, and to improve function. Appendix I shows two standardised classifications of disability which are commonly used by clinicians.

## Identifying the “Ideal Seated Posture”, Goals of Special Seating and Special Seating Solutions

### Identifying the ideal seated posture

Historically, the 90-90-90 posture (90 degrees of flexion at the hips, knees and ankles) was seen as the ideal seating position. However, more recent practice views this simply as a useful ergonomic perspective (Engström, 2002). From an anatomical view point the goal is to achieve maximum orthopaedic symmetry between left and right sides of the body via a neutral pelvis to avoid obliquity, rotation and posterior tilt of the pelvis (Lange 2001).

Research literature identifies that the 90-90-90 position is difficult to maintain over time (Ham et al 1998; Howe and Oldham 2001) and may hinder function (Engström 2002). Several authors advocate the idea of avoiding the 90-90-90 position.



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Kangas (2002) argues that for functional performance, movement and tone are required, but the 90-90-90 position prevents functional performance as it is essentially a resting position and too restrictive. Minkel (2001) proposes that the goal of adapted seating should extend beyond achieving perfect symmetry, but should focus on providing external support, at the angles needed by an individual to achieve an upright, stable and functional position.

Shimizu et al (1994) acknowledges that deviation from the optimal upright position is often required to accommodate for fixed deformities and abnormal postural tone, yet basic positioning principles should be maintained. This is to provide equal distribution of weight, for support, stability and comfort.

It may be concluded that the 90-90-90 position is a useful starting point to for symmetry with further seating adaptations / components being used to assist function.

## Goals of Special Seating

Based on clinical and research evidence, it is widely accepted and common practice for the general goals of seating and positioning to include:

- 1 Normalising tone or decreasing its abnormal influence on the body
- 2 Maintaining skeletal alignment
- 3 Preventing or accommodating skeletal deformity
- 4 Providing a stable base of support to promote function
- 5 Promoting increased tolerance of the desired position
- 6 Promoting comfort and relaxation.
- 7 Facilitating normal movement patterns or controlling abnormal movement patterns
- 8 Managing pressure or preventing the development of pressure sores.
- 9 Decreasing fatigue
- 10 Enhancing autonomic nervous system function (cardiac, digestive and respiratory function)
- 11 Facilitating maximum function with minimum pathology (Jones and Gray 2005).

## Special Seating Solutions

Special seating systems aim to address the general clinical goals by providing optimum:

- 1 Pelvic stability
- 2 Trunk and head alignment
- 3 Leg and foot positioning

Historically, manufacturers have developed seating solutions which are custom moulded, modular or a combination of the two.



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## Custom moulded seating solutions

Custom moulded seating is that which conforms to the exact shape of the individual's spine, buttocks and thighs, by casting the shape of the person either by vacuum moulding or by using complex digital technology. Moulding is typically carried out by a suitably qualified orthotist or bioengineer. The benefits of moulded systems are that there is potentially better weight distribution, and (assuming correct moulding) the system fits exactly to the user's unique body shape. However, such moulds tend to be a snapshot in time of the person's posture. There is no room for growth or changing posture, there can be difficulty with transfers, and the lack of room for movement may interfere with functional abilities (Cook & Hussey, 2002).

Therefore moulded seating systems tend to be used only for individuals with the most complex body shapes and fixed deformities (Cogher et al, 1992). Individuals requiring moulds will always be rated as GMFCS Level V and Chailey Level 1 (see Appendix I).

## Modular seating solutions

Modular seating is that which uses a range of adjustable components such as seat base, seat back, foot rests, head support and mobility bases along with a choice of accessories such as pelvic supports and lateral trunk supports, to meet a scope of clinical needs. The exact clinical need must first be assessed by a suitably qualified occupational therapist or physiotherapist, and the components and accessories selected and configured to match these identified needs. Depending on the complexity of the needs of the user, and the subsequent set-up, the modular system may perform like a bespoke piece of equipment.

The benefits of modular seating are the room for growth and adjustment, ease of transfers, increased potential for function and the reusability of the system.

However, modular seating may not have the required range of adjustment for those with the most complex needs. Individuals using modular seating may range in abilities from GMFCS Levels II-V and Chailey Levels 1-7 (see Appendix I).

## Combination seating solutions

Combination seating is that which uses moulded parts (usually either a seat base or seat back) along with modular parts. This is a less common occurrence, with children who are prescribed combination seating generally having an unusual level of severe disability either at their pelvis/legs (moulded seat base with modular seat back) or their spine (moulded seat back with modular seat base).

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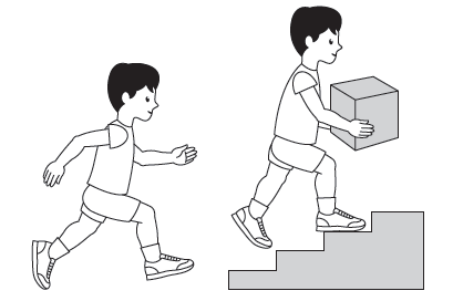
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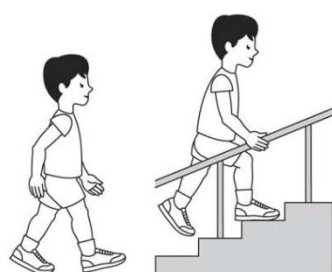


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## Appendix I: Standardised Classifications of Disability

### Gross Motor Function Classification System (GMFCS) for Mild-Severe Needs

GMFCS	Summary
 <p data-bbox="354 850 511 913"><b>Level I</b> (Mild Needs)</p>	<p data-bbox="698 478 1153 510"><b>In general: walks without limitations:</b></p> <p data-bbox="698 552 1372 651"><b>Age 2-4:</b> Children floor sit with hands free to manipulate objects; crawl, pull to stand and furniture walk. Achieve walking between 18-24months.</p> <p data-bbox="698 657 1421 756"><b>Age 4-6:</b> Children get into and out of, and sit in a chair without using hands for support; walk indoors and outdoors; climb stairs; emerging ability to run and jump.</p> <p data-bbox="698 762 1412 861"><b>Age 6+:</b> Children walk and run; climb stairs without a railing; can perform gross motor skills such as running and jumping but speed, balance and co-ordination are limited.</p>



**Level II**  
(Mild to Moderate Needs)

#### In general: walks with limitations

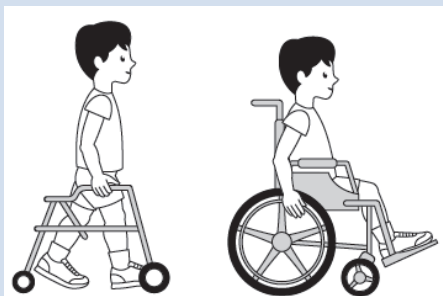
**Age 2-4:** Children floor sit, but have difficulty with balance when both hands are free to manipulate objects; movements in and out of sitting are performed with adult assistance; may crawl, cruise, or walk using a hand-held device (sticks, crutches or walkers that do not support the trunk) when *first* learning to walk.

**Age 4-6:** Children sit in a chair with both hands free to manipulate objects; may move in/out of chair or up/down from floor but often need a stable surface to push or pull up on; may use wheeled mobility for long distances outdoors; need a railing to walk up and down stairs; unable to run or jump.

**Age 6+:** Children walk in most settings; have difficulty on uneven ground, over long distances, crowded or confined spaces etc.



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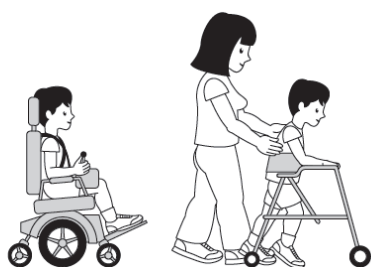
**Level III**  
**(Moderate Needs)**

**In general: walks using a hand-held mobility device**

**Age 2-4:** Children maintain floor sitting by “W” sitting and may need adult assistance to assume sitting; creep or crawl as main means of mobility; may walk short distances using a hand-held mobility device indoors, needing adult assistance for steering and turning; may use wheeled mobility outdoors or in the community.

**Age 4-6:** Children sit on a regular chair but may require pelvic or trunk support to maximise hand function; can usually walk with hand-held mobility device on level surfaces; transported for long distances.

**Age 6+:** Children may require a seat belt for pelvic alignment and balance; walk with hand-held device indoors; may self-propel or use powered mobility for outdoors.



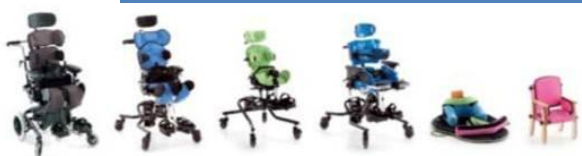
**Level IV**  
**(Moderate to Complex Needs)**

**In general: self-mobility with limitations; may use powered mobility**

**Age 2-4:** Children floor sit when placed but need hands for balance and support; frequently need special equipment for seating and standing; self mobility over short distances achieved through rolling, creeping and non-reciprocal crawling.

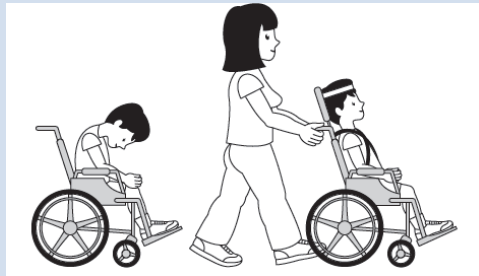
**Age 4-6:** children can sit on a chair but need special seating for trunk control and hand function; can move in/out of chair with assistance from adult or firm surface; walks short distances with walker; transported in community; may be independent with powered mobility.

**Age 6+:** Children mobilise with physical assistance or powered mobility; special seating required; help needed with transfers.



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In general: transported in a manual wheelchair



**Level V**  
**(Complex Needs)**

**Age 2-4:** all areas of motor function limited; restricted voluntary control and ability to maintain posture against gravity; functional limitations not fully compensated for by special equipment.

**Age 4-6:** As above. No means of independent movement. Some children achieve self-mobility through powered chair with extensive adaptations.

**Age 6+:** Children limited in ability to maintain anti-gravity postures; special equipment used to improve head alignment, seating, standing and mobility, but limitations not fully compensated for; transfer only with assistance; may achieve self-mobility through powered chair with extensive adaptations.

Reference: Palisano R, Rosenbaum P, Bartlett D, Livingston M (2007)

GMFCS – E&R: Gross Motor Classification System Expanded and Revised.  
CanChild Centre for Childhood Disability Research, McMaster University,  
Canada.



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## Chailey Levels of Ability for Complex-Mild Needs

Chailey Levels	Summary
	Cannot be placed in the sitting position; trunk weight cannot be brought forwards over sitting base for a variety of reasons including a strong tendency to extend, extreme floppiness or fixed deformities.
<b>Level 1 (Complex Needs)</b>	
	Can be placed in a sitting position; needs holding to stay in position; trunk weight can be brought forward over base; pelvis posteriorly tilted; shoulder girdle retracted or neutral; back profile rounded.
<b>Level 2 (Complex – Moderate Needs)</b>	
	Ca be placed in a symmetrical sitting position; can maintain as long as he does not move; pelvis in neutral tilt; chin tucked; shoulder girdle protracted; hands propping or otherwise aiding balance; weight is forward over sitting base.
<b>Level 3 (Complex – Moderate Needs)</b>	



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**Level 4 (Moderate Needs)**

Can be placed in a symmetrical sitting position; able to move trunk forward within base; able to return to upright; able to move laterally within base both ways; able to rotate trunk within base; pelvis is anteriorly tilted; can retract chin; shoulder girdle is protracted; arms can move to shoulder height; back profile is upright; hands can be brought to midline.



**Level 5 (Moderate Needs)**

As for level 4 plus: able to tilt pelvis anteriorly and posteriorly enabling trunk weight to fall behind base, allowing unilateral leg movement; arms can move above shoulder height; can use hands freely; can recover balance after leaning to either side.



**Level 6 (Moderate – Mild Needs)**

As for level 5 plus: can sit independently; can transfer weight outside of sitting base to leave the position.



**Level 7 (Mild Needs)**

As for level 6 plus: can move into the sitting position.

Reference: Pountney TE, Mulcahy CM, Clarke SM, Green EM (2001) The Chailey Approach to Postural Management. Active Design.

