Guidance on Assisted Standing for Children with Cerebral Palsy

Sue Bush¹, N Daniels², J Caulton³, A Davis⁴, J Jex⁵, G Stern⁶, E William⁷, S Bostock⁸,
¹Highly specialist paediatric physiotherapist, Northwick Park Hospital, ²Lecturer in Occupational Therapy, University of Derby, ³Lecturer in physiotherapy, University of Keele, ⁴Paediatric physiotherapist, ⁵Clinical specialist physiotherapist, Active Design Ltd. ⁶Senior Bobath tutor, freelance lecturer and clinical consultant, ⁷Independent paediatric physiotherapist, ⁸Manager Equipment and ABI / ADP, Novita Children’s Services, 171 Days Rd, Regency Park, South Australia 5942
All correspondence to Sue Bush: suebush2001@yahoo.com

Abstract: This systematic review was written to provide an evaluation of the evidence that is currently available to support the use of assisted standing for children with cerebral palsy. The conclusions drawn are intended to inform the reasoning of the clinician and to identify topics that need further research.

As part of their programmes of treatment, physiotherapists often assist children with cerebral palsy to stand. This can be achieved in various ways but most commonly using assistive technologies known as standing supports, standing frames or standing devices. Claims have been made that assisted standing can increase bone density, improve hip joint development, reduce muscle spasticity, maintain muscle length and prevent contractures. Physical benefits are also believed to include improved circulation, respiratory, bowel and bladder function whilst psychological and social benefits are believed to come from the increased self esteem derived from a child’s ability to interact with peers at eye level.

Despite the extent to which assisted standing is used by clinicians published scientific evidence to adequately support these potential benefits is limited. No published guidance is currently available to inform the clinical reasoning of prescribers of standing programmes. There appears to be a lack of consistency in relation to desired treatment outcomes, timing, type of equipment and optimal positioning, by those who prescribe standing programmes.

Background
The Gross Motor Classification System, (Palisano et al,1997) which classifies the functional abilities of children with cerebral palsy, indicates that those children with levels II –V may require some assistance to achieve or maintain a standing position.

As part of a programme of treatment, physiotherapists often assist children with cerebral palsy to stand. This can be achieved in various ways but most commonly using assistive technologies known as standing supports, standing frames or standing devices. A wide range of these products are commercially available, each with varied features and designs, to offer the standing support necessary to meet the diverse needs of this client group. The clinical benefits that can be derived from this intervention are believed to be wide ranging and include a number of physiological, psychological and social benefits.

Gudjonsdottir (1997) discussing the clinical implications of musculoskeletal development in cerebral palsy, advised that the aim of physiotherapy should be to slow down the progression of deformity. Preventing contractures was seen to be important in enhancing movement and weight bearing activities and promoting anti-gravity postural control, active movement and weight-bearing. Preserving good alignment helps to counteract the deforming forces, maintain muscle length, promote normal joint formation, and delay bone loss.

Pountney (2002) includes the developmental position provided by postural support in standing, as part of a comprehensive programme of 24 hour positioning. This could encourage the development of a higher level of postural ability to prevent the development of damaging asymmetrical postures.

Claims have been made that assisted standing can increase bone density (Stuberg 1992), improve hip joint development (Campbell, Palisano and Van der Linden 1994), reduce muscle spasticity, maintain muscle length and prevent contractures (Edwards 2001, Stokes 1998. Physical benefits are also believed to include improved circulation, respiratory, bowel and bladder function (Bromley 1998) whilst psychological and social benefits are postulated to relate to increased self esteem derived from a child’s ability to interact with peers and family members at eye level. (Brogren 1995)

A consensus statement on postural management (Gericke, 2006) advised that children in GMFCS IV-V should start postural management in lying as soon as appropriate after birth, in sitting from 6 months, and in standing from 12 months. This document was unfortunately published without references to support the advice given.
The literature has been reviewed and collated in the following categories:

- **Function**
- **Bone mineral density**
- **Hip development**
- **Neuromuscular effects**
- **Physiological effects**
- **Perceptions of users of standing frames**

**FUNCTION**

Woollacott and Burtner (1996), in an observational, longitudinal study (Sackett level 2B) to understand the development of neural and musculoskeletal contributions to the development of stance balance control, found that typically developing children who were asked to stand on a moveable platform with a crouched posture similar to that seen in many children with cerebral palsy showed EMG responses to platform perturbations that approximated to those of the children with cerebral palsy. In this study joint alignment was seen to influence muscle responses and there was increased frequency of co-activation of both proximal-distal and agonist-antagonist muscles induced by the crouched posture. (The authors do not state how many children were studied in this research)

Children with cerebral palsy exhibit limited motor behaviours, lacking the variation of their normally developing peers, and suggesting a limited repertoire of primary neuronal networks. Hadders Algra (2000), in a discussion of neuronal group selection theory, reviews the current knowledge and...
theories of movement acquisition and advocates therapy that extends sensorimotor experience for the young child with cerebral palsy by means of the application of variable postures to counteract the infant’s propensity for stereotypical activity.

Although therapists have reported improved functional position to be the highest priority for use of a standing support (Wintergold et al, 2008), studies that have evaluated the effect of positioning on a child’s function are scarce. Published literature ranges from dated single case studies (Ivey et al 1981, Cohen 1978) to low quality randomised control trials. (Miedaner and Finuf 1993, Kramer et al 1992)) and one cohort study (Noronha et al 1989).

Noronha et al (1989) found no significant difference in the time required for ten boys with spastic diplegia to complete the Jensen Hand Function Test when comparing upper limb activities in sitting and standing although did record a faster time for feeding activities whilst the children were positioned in a standing frame. Miedaner and Finuf (1993) found positioning in adaptive equipment to improve the outcome of psychological testing in 67% of cases using a sample of twelve children with a diagnosis of spastic quadriplegia or diplegia. However only one child in the study used a standing frame.

It may not be the use of a sitting or standing position alone which affects the outcome but the features of the specific equipment and the position it enables a child to achieve; for example the distance between the shoulder girdle and the table top. The angle of tilt of the standing frame may influence postural tone, e.g. forward tilt may increase flexor activity around the thoracic spine and shoulder girdle and this may also have an impact on function. Appropriate assessments should therefore be used to assist this decision making process.

Case studies have anecdotally found the use of a standing support to improve upper limb function (Ivey et al 1981, Cohen 1978) whilst studies that have used objective measures to record this outcome have reported inconclusive results (Miedaner and Finuf 1993, Kramer et al 1992 Noronha 1989)

**Summary -function**

The lack of research carried out in this area, the age of published studies and the use of small samples makes conclusions difficult to draw in relation to a child’s function in standing. Therapists should therefore be aware that for each individual child positioning may have an impact on function and therefore analyse each task in accordance with an individual child’s needs

**BONE MINERAL DENSITY AND STANDING**

Bone mineral density (BMD) is reported to have a positive correlation with bone strength and has been used as a predictor of fracture risk in adults (Marshall 1996: WHO 1994). It is reasonable to assume children with reduced bone mineral density are more likely to fracture than their peers with typical age related BMD. Henderson (1997) noted that fracture rates were similar between children with spastic quadriplegia despite a sedentary lifestyle and lack of exposure to traumatic events compared with typically developing children. This section does not intend to review factors affecting BMD in children with cerebral palsy. However, the literature pertaining to the influence of static and dynamic standing on BMD, the angle of standing balance and also post fracture protocols is reviewed within this section

**Static standing**

Stuberg’s frequently referenced paper which investigated the relationship between BMD and standing has influenced the paediatric physiotherapy community since its publication (Stuberg 1992). He stated that 1 hour of static standing five times a week was necessary to retard loss of BMD. However these findings were preliminary and final findings have never been published. This publication also gave limited detail of the study design, sample and type of data collected making it difficult for reliable conclusions to be drawn or for the study to be replicated. Many of the conclusions of Stuberg’s review are extrapolated from research on animals, adults and healthy athletes.

Some confusion also exists regarding the discontinuation of a standing programme and its effect on BMD. Stuberg (1991) suggested that BMD was reduced following an interval of 8 weeks. It was later reported that a break from standing over a period of at least 8 weeks does not significantly decrease BMD as measured by absorptiometry (Stuberg et al 1991).

A more recent study by Caulton et al (2004) aimed to determine whether 50% longer periods of standing in either upright or semi-prone standing frames would lead to an increase in vertebral and proximal tibial bone mineral density of 26 non-ambulant children with cerebral palsy. A 6% mean increase in vertebral bone mineral density was found in the intervention group, but the tibial site showed a small negative change of -0.8% compared with the control group. There was no description of the angle at which the therapists chose to stand the children in either group or of the knee joint positions which
may affect the tibial measure. Standing in the intervention group ranged from an average weekly duration of 219 minutes to 675 minutes per week. This thorough piece of work raises issues regarding how much standing may be needed to influence bone density in the lower limbs.

**Summary - static standing on BMD**
Static standing may be useful to improve vertebral bone density and maintain long bone density but duration and frequency still seem to be open to debate.

**Angle of stand and weight bearing**
There is some, albeit limited, evidence that angle of standing affects the amount of weight borne through the feet. Curtis (1989) studied 13 children with cerebral palsy who were able to stand and walk with aids, and found that they bore most weight standing in an upright standing frame. However no child transmitted more than 75% of their weight through their feet in any frame. Miedaner (1990) investigated the effect of angle of stand on 23 children with cerebral palsy, none of whom could independently ambulate. The results (published as an abstract) demonstrated that children who had good head and trunk control bore most weight through their feet in an upright stander but that those who lacked head and/or trunk control bore most weight at 20° prone angle (i.e. 20° from perpendicular).

A recent study by Kecskemethy (2008) found variability in weight bearing during stands in 20 non-ambulatory individuals with quadriplegic cerebral palsy (aged 6 -21 years) and between standers with loads ranging from 37 -101% of body weight, measured through footplates with axial load cells.

**Summary - angle of standing**
Consideration should be given to the angle of standing where weight bearing is a goal of assisted standing.

**Dynamic standing**
It is well known that ambulant children with cerebral palsy have increased bone mineral density (BMD) compared to those who are severely involved (Wilmshurst et al 1996, Henderson et al 2004). Wilmshurst et al (1996) found that reduced broadband ultra sound attenuation was associated with the degree of immobility and reduced weight bearing. Although this paper is not directly related to standing it is indicative that dynamic activity may be required to improve bone quality.

Two studies have investigated dynamic standing in children with cerebral palsy. The first was a small study of 4 children with ‘severe’ cerebral palsy (Gudjonsdottir and Stemmons Mercer 2002). It examines how two types of prone stander (one conventional, one offering intermittent transfer of weight through left and right feet) affected bone mineral density. Standing was for an eight week period for 30 minutes daily, 5 days a week. Two children stood in a conventional stander and 2 in the dynamic stander. BMD in the femur and lumbar spine was measured by dual energy x-ray absorptiometry (DEXA).Three of the four children showed increased bone density in the distal femur on both sides. Two increased their lumbar BMD (1 control and 1 intervention). Increases were greater in the femur than the spine. The authors concluded that, with no adverse effects noted, the maintenance and improvement in BMD using the standing programmes is considered a favourable result.

Ward et al (2004) investigated low magnitude mechanical loading in children with disabling conditions (some of whom had cerebral palsy) who could stand independently but had limited mobility. Children were randomised to standing on an active or placebo plate for 10 minutes a day, five days per week, for six months. Spinal and tibial volumetric trabecular BMD was measured by 3-D QCT. Compliance with the protocol was 44%. The intervention group showed increases in tibial BMD whilst the control group showed a mean decrease. Increases in spinal BMD were greatest in the intervention group but this was not significant. ($p = 0.31$) However it may be clinically relevant for maintenance of spinal BMD. The outcome of this study is promising for future practice.

**Summary - dynamic standing**
Activity in supported standing may not only improve postural control but may also improve BMD.

Results from Ward’s study suggest dynamic stimuli during standing may be the way forward when the goal of standing is to improve BMD. The time for standing could possibly be significantly reduced.

However since motorised dynamic standers are not currently available in the UK continuation of conventional standing as a means of maintaining BMD seems appropriate.

Research is warranted into the effects on BMD of using dynamic activities in standing (e.g. targeted training). In addition, development of a tool for measuring weight bearing while standing is needed to facilitate comparison of equipment and orientation of standing frame.
Standing Post Surgery/Fracture

Bones that have been immobilised with continual lack of weight bearing are weaker and more at risk of fracture or re-fracture due to further bone mineral loss. (Sturm et al 1993) Care when handling and positioning in standing is therefore essential. It is necessary to weigh the potential risk of fracture or re-fracture with the desire to improve bone mineral density by weight bearing (Chad et al 1999)

Sturm et al (1993) identified several femoral fractures after hip spica immobilisation for hip operations. After cast removal two-person lifting was carried out for two months; all patients were gradually progressed from lying to sitting and kept non-weight-bearing for six weeks. Partial weight bearing with assistance or in a prone stander was then commenced. No indication of the actual positioning or timing for the standing protocol was given.

A further study that investigated complications following osteotomies (Stasikelis et al 1999) noted that most of the children used prone or supine standers following surgery, while in their casts. No details of timings were given. Post cast removal protocols were not clearly identified other than prone or supine standing in addition to physical therapy.

Summary -standing post surgery

Varying approaches to standing post surgery make it very confusing for the physiotherapist therefore close consultation with orthopaedic colleagues is required.

THE RELATIONSHIP BETWEEN SUPPORTED STANDING AND HIP DEVELOPMENT

Normal Hip Development

Children who have bilateral cerebral palsy are born with normal hips, but often have over activity of dominant muscle groups around the hip joint. (Beals 1969, Gudjonsdottir 1997)

Gudjonsdottir (1997) advises that weight-bearing activities are crucial for the congruent development of the femoral head and acetabulum.

Typically developing children kick, crawl, pull to stand and cruise. These movements strengthen the action of the hip abductors at their attachment to the greater trochanter, and induce a change in the biomechanical forces, altering the internal structure of the femoral neck. This causes the angle of the femoral neck to shaft to decrease and engage with the acetabulum. (Siffert 1981)The most important loads are weight-bearing and muscle tension applied in the appropriate magnitude and direction. Early changes to hip architecture have also been identified by Scrutton and Baird (1997, 2001) who highlighted the need for early surveillance and intervention to prevent hip subluxation.

The APCP (2001) published guidance for the prevention and management of hip dislocation in children with cerebral palsy. In section 1.3 ‘Treatment’ advised on current evidence that ‘Weight-bearing programmes can improve joint formation and reduce osteoporosis, and that children should weight bear for 60 minutes 4 to 5 times a week to enhance bone development secure hip joint. This advice is based on the recommendations of Stuberg discussed above.

NEUROMUSCULAR EFFECTS

Tremblay et al (1990) demonstrated a lowered EMG and torque at the ankle, measured during passive movement (at 30 and 60 cycles per second) after 30 minutes of stretch to triceps surae using a modified tilt table. These effects were statistically significant \( p<0.05 \) Capacity to voluntarily activate the plantar flexors was also significantly improved \( p<0.05 \), although activation of dorsiflexors was not affected. Effects were shown to last for 35 minutes but no measurements were taken after this.

Richards, Malouin and Dumas (1991) showed decreased resistance to passive movement, decreased EMG response and improved voluntary activation of triceps surae in children with cerebral palsy; however this did not translate into an observable functional change in gait when measured over one session.

Summary -neuromuscular effects

These two studies involved only small numbers of subjects and one session of muscle stretch. Further research needs to be carried out to determine how long the neuromuscular effects last for and whether repeated sessions can produce any change in function.

EFFECTS ON PHYSIOLOGICAL FUNCTION

The only evidence for respiratory effects of standing is a single case study which reported improved breathing and reduced stridor, but no objective measures were used (Ivey et al 1981).

Anecdotally, clinicians report improvement of bowel function in children with cerebral palsy as a result of supported standing but no research could be found to support this.

In a small study of 8 children with profound physical difficulties and 22 age and height matched,
normally developing controls, Stannard (2002) found the postural changes involved in being passively positioned in standing equipment resulted in changes in heart rate in both groups. This persisted in the control group but not in the disabled children who experienced a drop in systolic blood pressure. A ‘substantial proportion’ of the disabled children were found to have arrhythmias affected by postural change. This study suggests that if a child’s cardiovascular system is compromised, or if arrhythmias are known to be present, special care should be taken when introducing standing.

**PERCEPTIONS OF USE**

A qualitative study for the MHRA (Daniels et al 2004, Daniels 2005) highlighted the advantages and potential limitations of designs and features of standing frames, and assessed their ease of use and acceptability by users, therapists and carers. Twelve children, aged 8-14 years (10 with spastic quadriplegia, 2 with other presentations) trialled eleven different standing frames (prone, supine or multi-positional) in twenty three trials; twenty at school and three at home.

Opinions of children and therapists regarding use of standing frames were gathered regarding comfort, knee and pelvic supports as well as comfort, access, manouevrability, stability and weight-bearing.

The children all enjoyed standing and ten commented that they enjoyed using their current standing frames; five liked the colour, six liked the comfort. Two children disliked standing due to discomfort/knee pain. The children preferred frames that were given to them during the trial to their regular standing frames. Six children said they would like to move around more in their regular frame and four said that they would like to improve the comfort of their own frame.

Therapists evaluated the standing frames and gave their preferences considering: posture/position, ease of access and positioning, support, standing time tolerated, adjustability, aesthetics, possibility for child to control own position, transportability. Carers expressed their opinions using the same criteria. The research noted limited resources (such as time restrictions and financial restrictions), as playing a part in the prescription of equipment.

The children, carers and therapists expressed preferences, which should be considered when providing standing frames, to optimise and maximise benefits of standing, within the available resources.

**Summary - perceptions**

Good postural alignment and comfort were found to be the key to the successful use of standing frames and those with multiple adjustments received positive feedback.

Optimal prescription is individual to suit the needs of the child, and therapist awareness of the different available features is essential.

**Discussion**

From this review it will be evident that there is some, albeit limited, evidence to support the use of assisted standing for children with cerebral palsy to maintain BMD and produce short term changes in muscle tone. If it is possible to gain a well aligned standing position with adequate weight-bearing it may be possible to maintain or improve the integrity of the hip joint in non-ambulant children as a part of 24 hour postural management.

Support for physiological and psychosocial effects is anecdotal and remains unsupported by any good quality research.

For improving BMD Stuberg (1992) suggested 60 minutes, 4-5 times per week for maintaining bone density, although as previously stated this recommendation is based on research in animals and preliminary results from a piece of unpublished research.

Tremblay (1990) and Richards (1991) and colleagues produced short term changes in muscle tone with 30 minutes of stretch to triceps surae. Clearly positioning that produces adequate stretch will be crucial if the goal is to reduce muscle tone. The timing of the stand should be considered so that the child has an opportunity to make use of this temporary reduction in tone for improved functional activity either within or outside of the standing frame.

Where improvement in the integrity of the hip joint is the primary goal there should be particular attention to alignment and weight bearing. The selection of a standing support which allows some movement at the hip joint is also advocated.(Green 1993)

Consideration of the primary goal for standing is essential as timing, positioning and equipment may vary according to that goal. Treatment goals should therefore be clearly defined and reviewed regularly when designing and implementing a standing programme.

In order to achieve their goals clinicians need an
awareness of a range of equipment and should be prepared to carry out assessments using different standing supports to identify the best equipment for each individual. Children’s views should be sought at all stages of this process particularly with regard to comfort in standing.

There is a clear need for further research on all the effects of assisted standing in order to give a more solid evidence base on which to base clinical practice.

**Conclusion**

Physiotherapists have been using standing supports to achieve standing for children with cerebral palsy, aiming for a variety of results. Evidence is scant but supports the use of standing aids for goals of improving BMD, altering muscle tone and improving hip joint development. The use of assisted standing to obtain other effects has little evidence to support it. Clearly further research is required in order to give better guidance on standing positions, length of time in standing and frequency of standing. Also research is needed to establish the effects of standing on physiological and psychosocial functioning.

Therapists should define goals, consult the children at all stages and choose assessments and outcome measures to inform the efficacy of using standing to achieve these goals. These goals should be reviewed regularly and therapists should be aware of the variety of equipment that is available and best able to achieve goals.

**References**


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