The following are results of a literature review on Dynamic Wheelchair Seating. This term is used in multiple contexts. Some articles refer to dynamic seating but are addressing changes to the seated posture during manual wheelchair propulsion. Other articles refer to dynamic surfaces or cushions that “actively redistribute pressure on the body surfaces.” (i.e. Stephen Sprigle PhD, P. T. (2011). Assessing evidence supporting redistribution of pressure for pressure ulcer prevention: a review. Journal of rehabilitation research and development, 48(3), 203.). Some articles refer to a seat’s “dynamic stiffness” (i.e. Garcia-Mendez, Y., & Boninger, M. L. (2012). Dynamic stiffness and transmissibility of commercially available wheelchair cushions using a laboratory test method. Journal of rehabilitation research and development, 49(1), 7.).

This review explores literature in the context of dynamic wheelchair seating where a part of the wheelchair or wheelchair seating system moves in response to client movement.

Peer Reviewed Publications (in chronological order):

   https://www.healio.com/books/health-professions/occupational-therapy/%7B0494f75e-c42b-4f30-96d8-175a3fd90747%7D/seating-and-wheeled-mobility-a-clinical-resource-guide
   This chapter includes clinical applications of Dynamic Seating.

   https://doi.org/10.1371/journal.pone.0173662
   Pilot study investigating and characterizing the use of the two adjustable seating functions on the Elevation ultralight dynamic wheelchair during community use.

   Abstract from the European Academy of Childhood Disability 27th Annual Meeting. Design of dynamic seat with movement at ankles, hips, knees and back. Seat is instrumented to measure torque and angular displacement. The child demonstrated increased social engagement and function.

   Seating and Wheeled Mobility clinical applications, including Dynamic Seating

   Comfort is a high priority for families.

Of 64 discrete interventions, 24% have been proven to be effective. There is a gap between research and practice.

   The goal of this article is to develop an instrumented, dynamic seating system for people with extensor thrust using the Design Structure Matrix (DSM) tool.

   Vestibular input (movement) can reduce maladaptive behaviors.

   Quantitative movement analysis was used to compare movement during an extensor thrust with a dynamic back and with a rigid back. Results: decreased extensor thrust, increased range of motion in anterior-posterior direction, decreased vertical trunk movement during extension and decreased upper extremity movement (reduced large UE movement).

    Full access version: http://www.r82.co.uk/media/417996/fumagalli_research_dynamic_v_rigid.pdf
    Study:
    This study was done by Fumagalli in Italy. Quantitative movement analysis using 3D kinematics and pressure distribution was used to compare movement during an extensor thrust with a dynamic back and with a rigid back in ten people with cerebral palsy and dystonia. An R82 x:panda seating system was used.
    Results:
    Participants experienced decreased extensor thrust forces, increased range of motion in the anterior-posterior direction (the client could move their trunk forward and back), decreased vertical trunk movement during extension (shear) and decreased upper extremity movement (reduced large UE movement and increased smoothness of movement). The authors concluded that this could lead to increased occupant comfort (decreased pain) and quality of postural stability.

    Study:
The goal of this study was to determine the effects of a dynamic seating system (movement at hips and knees) as a therapeutic intervention in children with cerebral palsy. The study included twelve children: half received static seating and half received dynamic seating. Each child was evaluated in the areas of range of motion, muscle tone (Modified Ashworth Scale), motor function (Gross Motor Function Measure), and level of disability (Pediatric Evaluation of Disability Inventory) at initiation, 3 months and 6 months. A Kids Rock wheelchair was used.

Results:
Both groups improved in motor function (particularly in Sitting and Crawl/Kneel) and level of disability (self-care, mobility, social function). The authors concluded that a larger, more homogeneous group would likely show significant differences in muscle spasticity, gross motor function and disability. Trends showed a decrease in spasticity, an increase in range of motion and improvement on the GMFCS (Gross Motor Function Classification System) for crawling and walking.

Development of a simulator that allows independent adjustment of trunk, pelvis and thighs to improve posture.

Dynamic cushion demonstrated increased attention and alertness in response to movement.

https://www.tandfonline.com/doi/abs/10.1080/17483100701661314
Relationship of seat inclination and postural control.

Study:
The objective of this study was to examine the effectiveness of an experimental dynamic wheelchair seating system designed to relieve discomfort for long-duration wheelchair users. The study used the Tool for Assessing Wheelchair discomfort (TAWC). Two wheelchair users each tested an initial design and feedback guided the development of a second design.

Results:
The study found that dynamic seating reduced spasticity intensity and contact pressures, improved postural stability, increased comfort (decreased pain), improved function, prevented damage to the seating system, and increased vocal and/or breathing ability.

Children learn to move by moving.


**Study:**
This Retrospective study of the Aktivline dynamic seat occurred in Germany.

**Results:**
The study found that children and adolescents could sit longer, felt less pain, and demonstrated improved posture, joint mobility, and digestion.


19. VP Patrangenaru: **Development of a dynamic seating system for high-tone extensor thrust.** Thesis. 05/2006. Georgia Institute of Technology. [https://smartech.gatech.edu/handle/1853/10438](https://smartech.gatech.edu/handle/1853/10438)
An analytical dynamic model of a human subject undergoing an extensor thrust on a rigid chair was created. A Dynamic-Hingeback Seating System was also developed. Desired motion of the system occupant during extensor thrust was verified.

Development of a system to determine human-generated motions and forces during unconstrained extensor thrusts. Effectiveness and reliability established.

Development of a system to determine human-generated motions and forces during unconstrained extensor thrusts. Effectiveness and reliability established.
Similar to article above.

This study showed reduction of pain and improvement of movement control of the upper extremities, trunk, and head.

23. Ferrari A. (2003). "In terms of posture and postural control (In tema di postura e di controllo posturale)", Giornale Italiano di Medicina Riabilitativa, 17 (1); 61-74.

(Study unavailable)

**Results:**
Researchers observed that the use of a thoroughly designed dynamic seating system decreases intensity and duration of extension at the trunk and head, decreases hyperextension of the neck during spasms, decreases extension of the lower limbs, maintains body alignment with the components of the posture system during and after spasms, conserves energy consumption, and improves swallowing and, as a result, reduces drooling.


[http://www.physiotherapeuten.de/pt/archiv/2002/kg05/a_kg07.html](http://www.physiotherapeuten.de/pt/archiv/2002/kg05/a_kg07.html)


Development of an objective measure to quantify the degree of spasticity.


A method of calculating the net forces and torques on human joints using inverse dynamics and an 11 segment model of the human body.

**Non-Peer Reviewed Publications**


[http://ethos.bl.uk/OrderDetails.do?uin=uk.bl.ethos.605962](http://ethos.bl.uk/OrderDetails.do?uin=uk.bl.ethos.605962)


**Seating Dynamics** | p: 303-986-9300 | f: 303-986-9301 | sales@seatingdynamics.com
https://mobilitymgmt.com/Articles/2011/02/01/Keeping-Kids-in-Motion.aspx

https://mobilitymgmt.com/articles/2010/05/05/dynamic-seating-tech.aspx?sc_lang=en

http://www.nrnts.org/pdfs/CaseStudies/Directions_vol5_2009_44_46.pdf


(link not available)

Presentations and Proceedings


This session presented a current feasibility trial to guide and inform the design of a full scale trial to assess acceptability and efficacy of whole-body dynamic seating on activity, participation, and quality of life in preschool children with dystonic cerebral palsy, using mixed qualitative and quantitative methods.


Georgetown, TX.


https://www.occupationaltherapy.com/ot-ceus/course/dynamic-seating-3530


Seating Dynamics | p: 303-986-9300 | f: 303-986-9301 | sales@seatingdynamics.com


   At the time of this presentation, this group was designing a seating system for children ages two to five years with whole body dystonia. They were also determining the feasibility of evaluating the impact of the seat with functional outcome measures suitable for use with this group, as preparation for a subsequent trial with a group of six children. Item #2 on this list presents their progress.


This session presented research that was on-going and stated that long-term testing was underway. The study was testing whether the KiSS dynamic seating system impacted body motion or seat interface pressure.

Results:
Preliminary testing did not show a significant effect.

Recording: [https://www.youtube.com/watch?v=LO4y_VeHn8k&feature=youtu.be]


This session describes the development of a novel dynamic seating system. Initial prototypes were evaluated by two children. The final prototype was then used in further studies (see items #2 and #14 above).

Results:
The following outcomes were noted: increased vocalization, increased movement, one child was able to access a switch in the dynamic seat (and unable to in their static seating), reduced spasm intensity, increased symmetry in posture, increased head control, and the onset of movement (of the dynamic seat) reduced the rate of increase of spasm. The client also expressed preference for the dynamic option.

This session described an evaluation of the impact of a simulated dynamic foot support on an adult with Dystonic cerebral palsy who experiences whole body extensor spasms. This study was designed to optimize the mechanical
design of the foot support to then use in a pilot study scheduled for February 2014. It is unknown if this study occurred.

Results:
Use of the simulated foot support increased head and arm control and the client reported that it was easier to drink and swallow. It should be noted that the simulated support was provided only by the clinician’s hands.


A mobile strain gauge data acquisition system was developed to capture the forces and moments in wheelchair components in a rigid and dynamic seating system. The research team determined the magnitude of the contact force on the backrest, footrests and center of pressure (COP) on the seat during ADLs (Activities of Daily Living). Footrest forces and moments varied, but back support interface forces remained the same for each system (static and dynamic). Average force on the backrest was 60-70% BW (Body Weight) and 20% BW on each footrest. Peak forces (during extension) were 200% BW on backrest and 600% BW on footrests.

Results:
Clients are able to exert up to 200% of their body weight against the backrest and 600% of their body weight against the footrests during extension. Dynamic seating can be used to diffuse these forces.


   [http://www.iss.pitt.edu/iss_pre/iss_pre_doc/iss_2011.pdf](http://www.iss.pitt.edu/iss_pre/iss_pre_doc/iss_2011.pdf)


   Describes the Elevation wheelchair which is an ultralight rigid manual wheelchair that allows the client to adjust the seat height (posterior portion raises) and backrest recline angle. The chair weighs less than 25lbs. It is operated by 2 gas springs under the seat and a lever.
   The authors define dynamic seating as “the user’s ability to easily and quickly adjust their seating position independently.”

   Available on request from the author: philip.riches@strath.ac.uk / bioengineering1@hotmail.com

   Addresses microstimulation in seating systems


   A case study describing a seat designed with dynamic footrests and a dynamic back. The child showed reduced muscle tone and improved head and hand control.

   Study reported a decrease in spasticity, an increase in range of motion and improvement on GMFCS, the positive effects of the dynamic posture system in subjects with children brain paralysis when in the seated position and during daily activities.


Shows that a dynamic seating system may positively affect the reduction of spasticity and the increase of certain functional activities.


Measurement and analysis of distribution of interface contact force and area under vertical vibration, analyzing cushion design.


Study found changes in hip extension force and duration using a dynamic back.


Design Articles


Patents


About the Author
Michelle is an occupational therapist with 30 years of experience and has been in private practice, Access to Independence, for over 10 years. She is a well-respected lecturer, both nationally and internationally and has authored numerous texts, chapters, and articles. She is the co-editor of Seating and Wheeled Mobility: a clinical resource guide, editor of Fundamentals in Assistive Technology, 4th ed., NRRTS Continuing Education Curriculum Coordinator and Clinical Editor of Directions magazine. Michelle is on the teaching faculty of RESNA. Michelle is a member of the Clinician Task Force. Michelle is a certified ATP, certified SMS and is a Senior Disability Analyst of the ABDA.