



Reference List – Bibliography and Abstracts of Studies on Seat Elevation and Standing Feature in Power Wheelchairs

Downloadable Studies – Direct Links Available

1. Nordstrom, B., et al., *The impact of supported standing on well-being and quality of life*. Physiother Can, 2013. 65 (4): p. 344-52.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3817885/pdf/ptc-65-344.pdf>

Purpose: To identify the characteristics of people who use standing devices and to explore their degree of device use, experiences with and reasons for standing, and perceived impact of the use of standing devices on well-being and quality of life (QOL).

Method: Anyone with a current prescription at the time for the study in any of five counties in Sweden ($n=545$), according to a national register of prescribed devices, was invited to participate in a descriptive survey; the questionnaire was mailed to respondents for self-rating.

Results: People between 2 and 86 years old were represented among respondents. Standing time decreased with increased age. Respondents who were totally dependent for mobilization or who had received their standing device more than 5 years earlier used their device most frequently. The most common reasons given for standing were to improve circulation and well-being and to reduce stiffness.

Conclusion: It is important to pay attention to the experiences of standing for this vulnerable group of people, as the use of a standing device has a positive impact on well-being and QOL.

2. Nordstrom, B., et al., *The psychosocial impact on standing devices*. Disabil Rehabil Assist Technol, 2014. 9 (4): p. 299-306.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4059228/pdf/IDT-09-299.pdf>

Purpose: The aim of this study was to explore the psychosocial impact of standing devices as experienced by users.

Methods: This is the second part of a comprehensive survey in five counties in Sweden where all the subjects with standing devices were invited to participate. The impact of standing devices on functional independence, quality of life and wellbeing was assessed using a questionnaire, Psychosocial Impact of Assistive Devices Scale (PIADS).

Results: The psychosocial impact of the standing devices was perceived as positive. The highest PIADS scores in relation to age were found in the oldest group, aged 65 years and older. The ability to walk and independence in ambulation resulted in higher scores than the use of a wheelchair and/or dependence on others. Those who stood often awarded higher scores in the PIADS questionnaire compared to those who used the device less frequently. When standing was integrated in various activities, its psychosocial impact received high scores.

Conclusion: The psychosocial impact of standing devices was generally experienced positively. The main results indicated that standing in a standing device had a value and we as professionals should ask the users about the intended purpose of their standing in order to prescribe the optimal device.

3. Paleg, G. and R. Livingstone, *Systematic review and clinical recommendations for dosage of supported home-based standing programs for adults with stroke, spinal cord injury and other neurological conditions*. BMC Musculoskelet Disord, 2015. 16: p. 358. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4650310/pdf/12891_2015_Article_813.pdf

Background: Sitting for more than 8 h a day has been shown to negatively impact health and mortality while standing is the recommended healthier alternative. Home-based standing programs are commonly recommended for adults who cannot stand and/or walk independently. The aim of this systematic review is to review effectiveness of home-based standing programs for adults with neurological conditions including stroke and spinal cord injury; and to provide dosage guidelines to address body structure and function, activity and participation outcomes.

Methods: Eight electronic databases were searched, including Cochrane Library databases, MEDLINE, CINAHL and EMBASE. From 376 articles, 36 studies addressing impact of a standing intervention on adults with sub-acute or chronic neurological conditions and published between 1980 and September 2015 were included. Two reviewers independently screened titles, reviewed abstracts, evaluated full-text articles and rated quality and strength of evidence. Evidence level was rated using Oxford Centre for Evidence Based Medicine Levels and quality evaluated using a domain-based risk-of-bias rating. Outcomes were divided according to ICF components, diagnoses and dosage amounts from individual studies. GRADE and the Evidence-Alert Traffic-Lighting system were used to determine strength of recommendation and adjusted in accordance with risk-of-bias rating.

Results: Stronger evidence supports the impact of home-based supported standing programs on range of motion and activity, primarily for individuals with stroke or spinal cord injury while mixed evidence supports impact on bone mineral density. Evidence for other outcomes and populations is weak or very weak.

Conclusions: Standing should occur 30 min 5 times a week for a positive impact on most outcomes while 60 min daily is suggested for mental function and bone mineral density.

4. Paleg, G.S., B.A. Smith, and L.B. Glickman, *Systematic review and evidence-based clinical recommendations for dosing of pediatric supported standing programs*. *Pediatr Phys Ther*, 2013. 25 (3): p. 232-47. https://journals.lww.com/pedpt/fulltext/2013/25030/Systematic_Review_and_Evidence_Based_Clinical.2.aspx

Purpose: There is a lack of evidence-based recommendations for effective dosing of pediatric supported standing programs, despite widespread clinical use.

Methods: Using the International Classification of Functioning, Disability, and Health (Child and Youth Version) framework, we searched 7 databases, using specific search terms.

Results: Thirty of 687 studies located met our inclusion criteria. Strength of the evidence was evaluated by well-known tools, and to assist with clinical decision-making, clinical recommendations based on the existing evidence and the authors' opinions were provided.

Conclusions and Recommendations for Clinical Practice: Standing programs 5 days per week positively affect bone mineral density (60 to 90 min/d); hip stability (60 min/d in 30° to 60° of total bilateral hip abduction); range of motion of hip, knee, and ankle (45 to 60 min/d); and spasticity (30 to 45 min/d).

5. Shields, R.K. and S. Dudley-Javoroski, *Monitoring standing wheelchair use after spinal cord injury: a case report*. *Disabil Rehabil*, 2005. 27 (3): p. 142-6.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3151726/pdf/nihms232720.pdf>

Purpose: An important issue in spinal cord injury (SCI) research is whether standing can yield positive health benefits. However, quantifying dose of standing and establishing subject compliance with a standing protocol is difficult. This case report describes a method to monitor dose of standing outside the laboratory, describes the standing patterns of one subject, and describes this subject's satisfaction with the standing protocol.

Method: A man with T-10 complete paraplegia agreed to have his commercially available standing wheelchair instrumented with a custom-designed logging device for a 2-year period. The micro-controller-based logger, under custom software control, was mounted to the standing wheelchair. The logger recorded date, duration, angle of standing, and start/stop times.

Results: The client exceeded a suggested minimum dosage of standing per month (130.4% of goal), choosing to stand for short bouts (mean = 11.57 min) at an average angle of 61 °, on an average 3.86 days per calendar week. He was generally very satisfied with the standing device and provided subjective reports of improved spasticity and bowel motility.

Conclusions: This case report describes a standing and surveillance system that allows quantification of standing dose. Future controlled studies are needed to evaluate whether standing can beneficially affect secondary complications after SCI.

6. Sprigle, S., C. Maurer, and S.E. Soneblum, *Load redistribution in variable position wheelchairs in people with spinal cord injury*. *J Spinal Cord Med*, 2010. 33 (1): p. 58-64.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2853329/pdf/i1079-0268-33-1-58.pdf>

Background/Objective: Tilt and recline variable position seating systems are most commonly used for pressure relief to decrease potential for skin breakdown. This study provides quantitative information on the magnitudes of loading on the seat and back during phases of tilt, recline, and standing. The objective of this study was to show that the amount of force reduction at the seat would differ across these 3 methods within their respective clinical ranges.

Participants: Six able-bodied (AB) subjects (2 men, 4 women) with a median age of 25 years, and 10 subjects (8 men, 2 women) with spinal cord injury (SCI) with a median age of 35.5 years.

Methods: Subjects sat on a power wheelchair with Tekscan pressure mats placed underneath a foam backrest and cushion. Data were collected at 5 positions for each method. Order of position and method tested were randomized. Linear regressions were used to calculate the relationships of normalized seat and backrest forces to seat and backrest angles for each chair configuration.

Results: Normalized seat loads had strong linear relationships with the angles of change in tilt, recline, and standing for both groups. Maximum decreases in seat load occurred at full standing

and full recline in the SCI subjects and in full standing in the AB subjects. Loads linearly increased on the back during tilt and recline and linearly decreased during standing for both groups.

Conclusions: Standing and recline offered similar seat load reductions at their respective terminal positions. Standing also reduced loading on the backrest. Recognizing that each method had clinical benefits and drawbacks, the results of this study indicate that tilt, recline, and standing systems should be considered as a means of weight shifting for wheelchair users.

7. Townsend, E.L., C. Bibeau, and T.M. Holmes, *Supported Standing in Boys With Duchenne Muscular Dystrophy*. *Pediatr Phys Ther*, 2016. **28** (3): p. 320-9.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5603175/pdf/nihms905020.pdf>

Purpose: To evaluate the safety, tolerability, and efficacy of supported standing in a small sample of boys with Duchenne muscular dystrophy (DMD).

Methods: Four 12- to 15-year-old boys with DMD engaged in a home-based supported standing program for 6 to 12 months. A single-subject design was employed to examine muscle length. Bone mineral density was assessed at 4-month intervals using dual-energy x-ray absorptiometry.

Results: Upright, sustained supported standing was tolerated in 3 of the 4 boys. Mean weekly stand times ranged from 1.3 to 3.3 hours. Improved hip or knee flexor muscle length was seen in 3 of the 4 boys. No boys showed improved plantar flexor muscle length or increased lumbar bone mineral density.

Conclusions: Findings offer preliminary empirical evidence addressing the safety, tolerability, and efficacy of standing in boys with DMD. Additional research with an emphasis on better program adherence is indicated.

8. Yang, Y.S., et al., *Sliding and lower limb mechanics during sit-stand-sit transitions with a standing wheelchair*. *Biomed Res Int*, 2014. 2014 : p. 236486.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4109664/pdf/BMRI2014-236486.pdf>

Purpose: This study aimed to investigate the shear displacement between the body and backrest/seat, range of motion (ROM), and force acting on the lower limb joints during sit-stand-sit transitions by operating an electric-powered standing wheelchair.

Methods and Materials: The amounts of sliding along the backrest and the seat plane, ROM of lower limb joints, and force acting on the knee/foot were measured in twenty-four people with paraplegia.

Results: Without an antishear mechanism, the shear displacement was approximately 9 cm between the user's body and the backrest/seat surfaces. During standing up, the user's back slid down and the thigh was displaced rearward, but they moved in opposite directions when wheelchair sat back down. A minimum of 60 degrees of ROM at the hip and knee was needed during sit-stand-sit transitions. The maximal resultant forces acting on the knee restraints could reach 23.5% of body weight.

Conclusion: Sliding between the body and backrest/seat occurred while transitioning from sitting to standing and vice versa. A certain amount of ROM at lower limb joints and force acting on the knee was necessitated during sit-stand-sit transitions. Careful consideration needs to be given to who the user of the electric powered standing wheelchair is.

9. Riek, LM., Ludewig PM., Nawoczenski DA. (2008) Comparative shoulder kinematics during free standing, standing depression lifts and daily functional activities in persons with paraplegia: considerations for shoulder health. *Spinal Cord* 46: 335-343
<https://www.nature.com/articles/3102140.pdf>

Study Design: Case series; nonparametric repeated-measures analysis of variance.

Objective: To compare and contrast three-dimensional shoulder kinematics during frequently utilized upper extremity weight-bearing activities (standing depression lifts used in brace walking, weight-relief raises, transfers) and postures (sitting rest, standing in a frame) in spinal cord injury (SCI).

Setting: Movement Analysis Laboratory, Department of Physical Therapy, Ithaca College, Rochester, NY, USA.

Methods: Three female and two male subjects (39.2±6.1 years old) at least 12 months post-SCI (14.6±6.7 years old), SCI distal to T2 and with an ASIA score of A. The Flock of Birds magnetic tracking device was used to measure three-dimensional positions of the scapula, humerus and thorax during various activities.

Results: Standing in a frame resulted in significantly less scapular anterior tilt (AT) and greater glenohumeral external rotation (GHER) than standing depression lifts and weight-relief raises.

Conclusions: Standing frame posture offers the most favorable shoulder joint positions (less scapular AT and greater GHER) when compared to sitting rest posture, weight-relief raises, transfers and standing depression lifts. Knowledge of kinematic patterns associated with each activity is an essential first step to understanding the potential impact on shoulder health. Choosing specific activities or modifying techniques within functional activities that promote favorable shoulder positions may preserve long-term shoulder health.

Full Study Available by Purchase

1. Antonio, T.S., et al. *Variations in Vital Signs Associated with the Postural Changes When Using a Stand-up Wheelchair in Patients with Spinal Cord Injury*. 2019. Cham: Springer International Publishing. https://link.springer.com/chapter/10.1007/978-3-319-94947-5_80

Abstract: Postural changes are important for the health of patients who are unable to walk, since they avoid complications in the acute stage. Transitions (standing/sitting/lying down) help vital functions remain in normal ranges. In Ecuador, rehabilitation in people with spinal cord injury is not mandatory, which leads to drawbacks, such as the appearance of bedsores and a decrease in muscle strength; both of them are associated with osteotendinous injuries that reduce the individual's independence. The aim of this study was to quantify changes in vital signs in patients with spinal cord injury in chronic stage when changing from a sitting to a standing position. The sample consisted of 10 patients with dorso-lumbar injury. Results show a significant improvement in blood pressure when standing up. Patients reported great satisfaction of being in a standing position and remarked the potential usefulness of this position to perform daily tasks or work because of the increase in the reach range of their upper limbs.

2. Chelvarajah, R., et al., *Orthostatic Hypotension Following Spinal Cord Injury: Impact on the Use of Standing Apparatus*. NeuroRehabilitation, 2009. 24(3):237-42.
<https://www.ncbi.nlm.nih.gov/pubmed/19458431>

Introduction: Upright posture confers numerous medical and social benefits to a spinal cord injured (SCI) patient. Doing so is limited by symptoms of orthostatic hypotension. This is a common secondary impairment among tetraplegic sufferers.

Objective: Establish the proportion of SCI patients who are restricted from using standing apparatus, such as standing frames and standing wheelchairs, because of inducing symptomatic orthostatic hypotension or the fear of developing these disabling symptoms.

Study Design: Survey conducted by Internet-accessible electronic questionnaire. Questionnaire validated for reliability and accuracy.

Results: 293 respondents. Mean age 44.6; 76% male. Median time from injury: 7 years. 38% suffered with orthostatic hypotension; majority were complete injuries and all (except one - T12) were T5 or above level. 52% replied that they were using standing wheelchairs or frames. Of these, 59 (20% of total) stated that orthostatic hypotension symptoms were limiting the use of their upright apparatus. Of those who did not use standing wheelchairs or frames, 16 (5.5% of total) reported that this was because of the fear of worsening their orthostatic hypotension.

Conclusion: Orthostatic hypotension restricts standing apparatus use in a large proportion (a total of 25.5% of respondents in this survey) of SCI patients.

3. Dawar, G., A. Kejariwal, and D. Kumar, *Design of a Modular Wheelchair with Posture Transformation Capabilities from Sitting to Standing*. Disabil. Rehabil. Assist. Technol., 2019:1-14.
<https://www.tandfonline.com/doi/abs/10.1080/17483107.2019.1604830?journalCode=iidt20>

Abstract: A significant part of world's population is handicap, with majority suffering from lower body disabilities – the body waist down is paralysed or weak. In many of such cases, upper body of the affected person was found to be deemed fit and was able to perform all tasks, if feasible. Being able to transform posture from sitting to standing position independently, helps perform routine jobs with ease, increases employment prospects and improves blood circulation to name a few. Most of the existing wheelchair designs are expensive because of the electrical and electronics involved requiring added maintenance, or contain a variety of subsystems thus decreasing reliability. The objective is to further increase the posture transformation capabilities in terms of cost, user effort, maintenance and life. The modular wheelchair allows the user to use his/her own energy and bodyweight to shift from sitting to standing position and back, in single smooth movement with zero dependency on electrical/electronic parts. Detailed design of links, mechanisms and load calculations were performed as per standard requirements. Prototype of the proposed design was also made and successfully tested for all its design features and capabilities as per the design standards and conditions of physically challenged people.

Implications for rehabilitation: Five bar link mechanism helps to reduce manual effort; there is no dependency on auxiliary power source; It is a low cost rehabilitation solution with increased posture transformation capabilities; Increased body movements will help to increase self-confidence of disabled person; Easy sitting and standing capabilities will improve overall bodily functions and remove psychological barriers.

4. Glickman, L.B., P.R. Geigle, and G.S. Paleg, *A Systematic Review of Supported Standing Programs*. *J. Pediatr. Rehabil. Med.*, 2010;3(3):197-213.
<https://www.ncbi.nlm.nih.gov/pubmed/21791851>

Objective: The routine clinical use of supported standing in hospitals, schools and homes currently exists. Questions arise as to the nature of the evidence used to justify this practice. This systematic review investigated the available evidence underlying supported standing use based on the Center for Evidence-Based Medicine (CEBM) Levels of Evidence framework.

Design: The database search included MEDLINE, CINAHL, GoogleScholar, HighWire Press, PEDro, Cochrane Library databases, and APTAs Hooked on Evidence from January 1980 to October 2009 for studies that included supported standing devices for individuals of all ages, with a neuromuscular diagnosis. We identified 112 unique studies from which 39 met the inclusion criteria, 29 with adult and 10 with pediatric participants. In each group of studies were user and therapist survey responses in addition to results of clinical interventions.

Results: The results are organized and reported by The International Classification of Function (ICF) framework in the following categories: b4: Functions of the cardiovascular, haematological, immunological, and respiratory systems; b5: Functions of the digestive, metabolic, and endocrine systems; b7: Neuromusculoskeletal and movement related functions; Combination of d4: Mobility, d8: Major life areas and Other activity and participation. The peer review journal studies mainly explored using supported standers for improving bone mineral density (BMD), cardiopulmonary function, muscle strength/function, and range of motion (ROM). The data were moderately strong for the use of supported standing for BMD increase, showed some support for decreasing hypertonicity (including spasticity) and improving ROM, and were inconclusive for other benefits of using supported standers for children and adults with neuromuscular disorders. The addition of whole body vibration (WBV) to supported standing activities appeared a promising trend but empirical data were inconclusive. The survey data from physical therapists (PTs) and participant users attributed numerous improved outcomes to supported standing: ROM, bowel/bladder, psychological, hypertonicity and pressure relief/bedsores. BMD was not a reported benefit according to the user group.

Conclusion: There exists a need for empirical mechanistic evidence to guide clinical supported standing programs across practice settings and with various-aged participants, particularly when considering a life-span approach to practice.

5. Goemaere, S., et al., *Bone Mineral Status in Paraplegic Patients Who Do or Do not Perform Standing*. *Osteoporos Int*, 1994. 4 (3): p. 138-43.
<https://www.ncbi.nlm.nih.gov/pubmed/8069052>

Abstract: Bone mineral density (BMD) was assessed by dual-photon X-ray absorptiometry at the lumbar spine (L3, L4), the proximal femur and the femoral shaft, and by single-photon absorptiometry at the forearm in 53 patients with complete traumatic paraplegia of at least 1 year's duration and in age- and sex-matched healthy controls. The patients did (n = 38) or did not (n = 15) regularly perform passive weightbearing standing with the aid of a standing device. Compared with the controls, the BMD of paraplegic patients was preserved in the lumbar spine and was markedly decreased in the proximal femur (33%) and the femoral shaft (25%). When considering all patients performing standing, they had a better-preserved BMD at the femoral

shaft ($p = 0.009$), but not at the proximal femur, than patients not performing standing. BMD at the lumbar spine (L3, L4) was marginally higher in the standing group (significant only for L3; $p = 0.040$). A subgroup of patients performing standing with use of long leg braces had a significantly higher BMD at the proximal femur than patients using a standing frame or a standing wheelchair ($p = 0.030$). The present results suggest that passive mechanical loading can have a beneficial effect on the preservation of bone mass in osteoporosis found in paraplegics.

6. Nickel, E., et al., *A Drive System to Add Standing Mobility to a Manual Standing Wheelchair*. Assist Technol, 2016: p. 1-7.
<https://www.ncbi.nlm.nih.gov/pubmed/27184610>

Abstract: Current manual standing wheelchairs are not mobile in the standing position. The addition of standing mobility may lead to improved health and function for the user and may increase utilization of standing wheelchairs. In this project, a chain drive system was fitted to a manual standing wheelchair, adding mobility in the standing position. The hand rims are accessible from both seated and standing positions. The prototype uses 16-inch drive wheels in front with casters in the rear. Additional anterior casters are elevated when seated for navigating obstacles and then descend when standing to create a six-wheeled base with extended anterior support. Stability testing shows the center of pressure remains within the base of support when leaning to the sides or front in both seated and standing positions. Four veterans with spinal cord injury provided feedback on the design and reported that mobility during standing was very important or extremely important to them. The veterans liked the perceived stability and mobility of the prototype and provided feedback for future refinements. For example, reducing the overall width (width from hand rim to hand rim) and weight could make this system more functional for users.

7. Nordstrom, B., A. Naslund, and L. Ekenberg, *On an equal footing: adults' accounts of the experience of using assistive devices for standing*. Disabil Rehabil Assist Technol, 2013. **8** (1): p.49-57. <https://www.ncbi.nlm.nih.gov/pubmed/22519553>

Purpose: The aim of the study was to illuminate the meaning that standing holds for persons who require standing devices.

Method: The phenomenological/hermeneutical analysis of the interviews was carried out using a life world-approach. Fifteen users of standing devices lacking the ability to stand independently participated in the interviews.

Result: Each person's lived experiences of standing in their devices indicated that the upright body position opens up an opportunity for connection to the outside world. An upright body position (i) alters the person's sense of self, (ii) augments the person's availability to the outside world, (iii) strengthens social interplay, and (iv) changes a person's motivation and their expectations over time.

Conclusion: Standing may be something that unites the body and self. Understanding the meaning of the altered body position that the use of standing devices opens up is vital for physiotherapists and occupational therapists prescribing these devices. Furthermore, it is important to take account of the subjective body, as well as the biological one, to enhance the adoption of different body positions and the person's experiences.

8. Nordstrom, B., et al., *The ambiguity of standing in standing devices: a qualitative interview study concerning children and parents experiences of the use of standing*

devices. *Physiother Theory Pract*, 2014. 30 (7): p. 483-9.
<https://www.ncbi.nlm.nih.gov/pubmed/24673188>

Aim: The aim of this study was to describe children's and parents' experiences of the significance of standing in a standing device.

Methods: Individual interviews were performed with six children/teenagers (aged 7-19 years) and 14 parents. The interviews were transcribed and analyzed using a qualitative content analysis.

Findings: The analysis resulted in the major theme, the duality of uprightness and the related themes: (1) the instrumental dimension of standing; (2) the social dimension of standing; and (3) the ambivalent dimension of standing. Each of the themes comprised several subthemes.

Conclusions: There is an inherent duality related to the use of a standing device. Standing in a standing device was seen as a treatment of body structures and functions, as well as a possible source of pain. Standing was considered to influence freedom in activities and participation both positively and negatively. The parents experienced that standing influenced other peoples' views of their child, while the children experienced standing as a way to extend the body and as something that gave them benefits in some activities. Physiotherapists working with children should take into account both the social and physical dimensions of using a standing device and consider both the child's and the parents' views.

9. Vorster, N., et al., *Powered standing wheelchairs promote independence, health and community involvement in adolescents with Duchenne muscular dystrophy*. *Neuromuscul Disord*, 2019.

Abstract: Duchenne muscular dystrophy is a common neuromuscular disorder involving progressive muscle weakness. A powered wheelchair standing device provides capacity to stand despite increasing muscle weakness. This study used qualitative methods to explore how adolescents with Duchenne muscular dystrophy used a powered wheelchair standing device in their daily lives. Semi-structured interviews were conducted with 12 adolescents, 11 parents and 11 teachers. Qualitative thematic analysis using a grounded theory framework was conducted to identify emerging domains. "Capacity to be able" was the central theme that emerged across the dataset: the introduction of the powered wheelchair standing device at a time when motor skills were declining enabled the adolescent to maintain and sometimes extend his independence. There were four underlying themes including (1) Independence, (2) Health, (3) Comfort, and (4) Community belonging and involvement. Each theme was illustrated in data collected from adolescents, parents and teachers. The device appeared to mitigate some of the challenges of progressive muscle weakness by providing the option for the individual with Duchenne muscular dystrophy to choose when and where to stand for participation in a range of activities, beyond what would be possible with existing therapeutic regimes involving standing frames.

10. Chang, K-H, Liou T-H, et al. (2014). Femoral neck bone mineral density change is associated with shift in standing weight in hemiparetic stroke patients. *American Journal of Physical Medicine and Rehabilitation*, Vol 93, No.6, 487-485
https://journals.lww.com/ajpmr/Abstract/2014/06000/Femoral_Neck_Bone_Mineral_Density_Change_Is.3.aspx

Objective: The aim of this study was to explore the association between the proportion of body weight bearing of the paretic leg and the rate of femoral neck bone mineral density loss in acute first-ever stroke patients.

Design: Patients were divided into those bearing less weight (<50%) on the paretic leg (n = 11) and those bearing more weight (≥50%) on the paretic leg (n = 11). The change in bone mineral density (grams per square centimeter per year) was calculated from the initial and follow-up dual-energy x-ray absorptiometry (≥6 mos). The proportion of body weight bearing was calculated from the body weight bearing of each leg, which was measured with the patient standing on a tilt table.

Results: Compared with the patients bearing more weight on the paretic leg, the patients bearing less weight on the paretic leg had faster reduction in femoral neck bone mineral density. The proportion of body weight bearing was associated with the change in bone mineral density in the paretic (adjusted $r^2 = 51.0\%$, $P < 0.001$) and nonparetic (adjusted $r^2 = 32.4\%$, $P < 0.005$) legs.

Conclusions: Compared with the patients bearing more weight on the paretic leg, the patients bearing less weight on the paretic leg had faster reduction in femoral neck bone mineral density. The proportion of body weight bearing was associated with the change in bone mineral density in the paretic (adjusted $r^2 = 51.0\%$, $P < 0.001$) and nonparetic (adjusted $r^2 = 32.4\%$, $P < 0.005$) legs.