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Original Research

Health Parameters in Standing and Nonstanding Nonambulatory Adults With Cerebral Palsy

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KEYWORDS
Exercise;
Osteoporosis;
Rehabilitation;
Therapeutics

Abstract *Objective:* To assess effects of standing exercise on adults with cerebral palsy with a focus on bone density, transfer skills, quality of life, and related health parameters.
Design: Prospective case series; pilot study.
Setting: Outpatient multispecialty clinic.
Participants: Nonambulatory adults with cerebral palsy, 13 standers and 7 nonstanders, comparable in age, sex, and other physical characteristics (N=20).
Interventions: Not applicable.
Main Outcome Measures: Bone mineral density per dual energy x-ray absorptiometry, stand pivot transfers, comprehensive blood serum assessments, fractures, spasms, perceived pain, and quality of life.
Results: No appreciable differences could be detected between the standing and nonstanding groups from baseline and over a 2-year subsequent study with respect to bone density, range of motion, comprehensive chemistry, hematologic blood serum levels, fractures, spasms, perceived pain, continence of bowel and bladder, seizures, orthotics, and orthopedic surgery. All individuals reported positive life effects of standing with only 1 negative effect reported: increased fatigue at the end of the day. Midline independent head control >30 seconds was identified only in the standing group. Functional stand pivot transfers were seen only in individuals with a history of standing.
Conclusions: The pilot data indicate no appreciable difference in measured outcome variables of a static nature between nonambulatory adults with cerebral palsy who stand compared with those who do not. We identified occurrences of improved head control and functional stand pivot transfers only in those with a history of standing. The value of a functional pivot transfer over the lifetime is difficult to overestimate. Encouragement is given toward future studies with a focus

List of abbreviations: CP, cerebral palsy; DEXA, dual-energy x-ray absorptiometry; GMFCS, Gross Motor Function Classification System.
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more toward functional outcome variables.

Cerebral palsy (CP) is a condition affecting people who live with primary impairment of the motor system affecting the trunk and extremities, with the onset occurring during fetal life or the developmental years.[1] The condition can be associated with seizures, as well as secondary impairments involving sensation, cognition, behavior, communication, and the musculoskeletal system.

Challenges with performing activities of daily living and community participation are intrinsic to the CP condition, which has a prevalence of about 2-3 per thousand live births.[2,3] The etiology of CP is multifactorial with risk factors including premature birth, infection, asphyxia, placental abnormalities, and other forms of perinatal and postnatal discord.[3]

People with CP are living longer along with advances in medicine, surgery, and related health care services.[4-6] Standing and the use of standing equipment is a common activity for children with CP, especially those with greater physical involvement at Gross Motor Function Classification System (GMFCS) levels IV and V.[7] A great deal of research has been reported to date regarding potential benefits of standing, which include improvement in bowel care, bone density, range of motion, pulmonary functions, and quality of life.[7-11] To our knowledge, none of these studies have focused solely on adults with CP and associated long-term life span benefits. The goal of this pilot study was to help identify occurrences, trends, or outcome variables that might facilitate additional research in this area of substantial need. Hypotheses at the onset were 3-fold.

Standers would display a higher bone density as measured by state-of-the-art bone densitometry. Participation in standing transfer activities would be higher in standers vs nonstanders. Standers would report more positive than negative benefits from standing as it relates to quality of life.

Methods

This study was a prospective case series in which bone density was measured in 2 groups of patients: those who were considered standers and those who were nonstanders. We screened medical records from all adult providers at our adult lifetime care clinic for all patients seen between 2007-2012. This lifetime care clinic is multidisciplinary in design with a core specialty-care team of internal medicine, physical medicine and rehabilitation, and orthopedics available during clinic hours for appropriate outpatient care. Additional onsite services include orthotics and prosthetics; durable medical equipment specialists; nursing; social services; physical, occupational, and speech therapy; and psychology in addition to outside visiting specialists in urology and psychiatry. Inclusion criteria for patients to participate in this study were spastic quadriplegia, GMFCS level V, aged 18 years or older, and the absence of knee or hip contractures that would preclude collection of dual-energy x-ray absorptiometry (DEXA) scan data from at least 2 of the specified sites. Exclusion criteria were estrogen or steroid use, inflammatory arthritis or related conditions, bone antiresorption therapy, spasticity secondary to traumatic brain injury, spinal cord injury, central nervous system degeneration, or other associated entity. To qualify as a stander, an individual had to display a minimum of 30 minutes of standing (inclination ≥70 degrees upward from the horizontal) up to 3 times a week for a minimum of 2 years prior to study entry. For classification as a nonstander, an individual had to display <3 minutes of weight bearing per day on the lower extremities, including mat activities and no functional crawling.

Prior to any study activities occurring, the use of human participants was approved by the local institutional review board. After careful discussion of study participation, risks, and benefits, informed consent was obtained from all participants able to consent or from their legally authorized representative if not. A total of 20 adults were recruited and consented, with 13 standers and 7 nonstanders present and participating in the study through enrollment (fig 1). Two nonstanding adults were excluded at a later date because they were unable to complete the required final visit at 24 months because of difficulties with transportation and staffing from rural locations. Eighteen participants completed 3 visits to the clinic including initial enrollment and at 12 and 24 months after the initial visit. In addition, information was collected via telephone at 6 and 18 months with the help of participant and/or personal care assistant. DEXA scanning was used for measurement of bone mineral density at each clinic visit. The DEXA equipment was of a Hologic QDR superscript TM series x-ray bone densitometer type with multidetector array, indexing table, and motorized C-arm.[a] The system has a switched pulsed dual energy x-ray tube operating at 100 kV and 140 kV, 5.0 mA average at 50% duty cycle, and a tungsten target. The standard readings of measurement included the lumbar spine, hip, distal

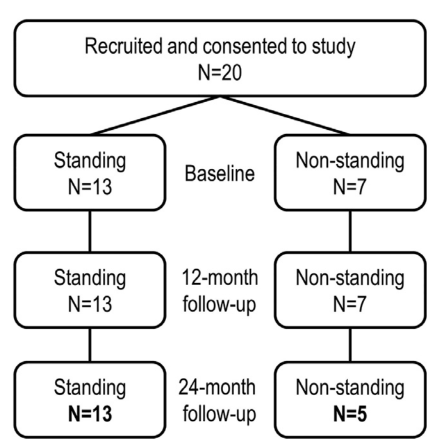

Fig 1 Study participant attrition.

forearm, and when possible the distal femur. The DEXA standard of change was based on the manufacturer's precision error for our machine when properly calibrated in absolute terms, approximately 0.010 g/cm^2. The least significant change was equal to 2.77 times the precision error (95% confidence interval).

In addition to DEXA readings, data collection included medical and surgical history, current medications, physical examination by a board-certified physiatrist and internal medicine—certified nurse practitioner, comprehensive physical and occupational therapy assessments, nutritional review, and annual laboratory draw. Laboratory assessments included a comprehensive chemistry panel, complete blood count, electrolytes, prealbumin, calcium, phosphorus, 25-hydroxyvitamin D levels, thyroid-stimulating hormone, free T4 thyroxin levels, and alkaline phosphatase. The Wong-Baker Visual Analog Scale for Pain, the Canadian Physiotherapy Association 11-Point Pain Scale, and a self-reported quality of life assessment were also completed.

Participant characteristics and health improvements by standing status (standers vs nonstanders) were reported using descriptive statistics. No statistical testing is reported because of the small sample size. Baseline values were defined as those values recorded on the enrollment visit.

Results

Those in the standing group stood for an average of 3.1± 1.5 hours per week (range, 1.5-5.0 hours). Standers had been standing for an average of 9.8±7.0 years (range, 2-20 years). Table 1 summarizes participants with respect to basic demographics, nutritional variables, anticonvulsant usage, bowel care, and spasms. Spasms were judged severe if capable of dislodging the participant from their manual wheelchair, mild if felt to be only a nuisance, and moderate for those in between. Standers were on average 12 years younger than nonstanders, and all participants were classified at GMFCS level V. There were no meaningful differences identified for the measured variables from baseline to any subsequent point in time between the standing and nonstanding groups.

Table 2 summarizes data collected on upper and lower extremity splints, tibia and knee height, spinal curvature, and body weight. Knee height was defined as the measure from the sole of the foot to the anterior most aspect of the distal femoral condyle (usually medial) with the knee in 90 degrees of flexion. Tibial height was defined as the measure from the most prominent aspect of the medial malleolus to the palpable superior surface of the medial tibial plateau with the knee in 90 degrees of flexion. No meaningful differences were identified between the standing and nonstanding groups at any point in time. There was an occurrence of more upper and lower extremity splints and bilateral splints (ankle-foot orthotics) noted in the standing group. Nonstanders were on average approximately 5 pounds heavier and had a tibial height of approximately 2 cm longer than standers.

Table 3 displays blood serum levels of measured entities for standers and nonstanders from baseline and then again at 12 and 24 months thereafter. The drawing of blood was sometimes done locally in the study participant's rural community, with difficulty accessing enough volume for all laboratory tests to be completed. Follow-up again was quite limited at 12 months and even more limited at 24 months for similar reasons mentioned above. The blood serum levels were all within satisfactory limits, with no meaningful differences in measured entities identified at any time including baseline between standers and nonstanders.

Table 4 summarizes data on previous orthopedic surgery, bony fractures, spasticity, and transfers. From baseline to subsequent measured points in time, no appreciable differences were noted between the groups for the variables listed. Of note is 1 individual with a standing pivot transfer in the nonstanding group who had been standing daily since early childhood up to present time. He would pull into standing on a fire pole—like device in his bathroom and bedroom for exercise on a daily basis. He would also use a similar technique to complete transfers to toilet and bed with the assistance of his wife. Because his time standing was <3 minutes overall for the daily cycle, he required classification in the nonstanding group. Functional stand pivot transfers were thus identified in only those individuals with a

Table 1 Participant characteristics for those in the standing and nonstanding groups

Variables	All Participants(n=18)	Standers(n=13)	Nonstanders(n=5)
Male (n)	12	8	4
Female (n)	6	5	1
Age (y), average (range)	30.0 (18-65)	27.0 (18-52)	39.0 (18-65)
Race, %	100 White	100 White	100 White
GMFCS level V (n)	18	13	5
Tube fed (n)	5	3	2
Vitamin D supplement (n)	9	6	3
Anticonvulsants (n)	6	5	1
Laxative use (n)	13	10	3
Constipation (n)	9	8	1
Lower extremity spasm severity (n)			
Mild	9	7	2
Moderate	6	4	2
Severe	2	1	1

Table 2 Participant characteristics for those in the standing and nonstanding groups

Variables	Participants Total (n=18)	Standers (n=13)	Nonstanders (n=5)
Splints/neuromuscular assistive devices worn (n)			
Upper extremity	7		1
Lower extremity	14	6	3
Bilateral extremity	10	11	1
Spinal curvature (n)			
Scoliosis	13	9	4
Kyphosis	1	1	0
Lordosis	3	2	1
Measurements (std)			
Knee height-left*	42.9 (3.1)	41.3 (3.2)	48.0 (2.0)
Knee height-right*	47.4 (3.1)	47.0 (3.4)	48.7 (1.8)
Tibia height-left*	35.7 (2.9)	35.1 (3.0)	37.3 (2.2)
Tibia height-right*	35.9 (2.9)	35.3 (3.0)	37.1 (2.4)
Weight†	118.7 (28.7)	117.5 (27.7)	122.5 (36.1)

NOTE. Scoliosis (>20 degree measured Cobb angle, thoracolumbar); kyphosis (≥60 degrees thoracic); lordosis (> 50 degrees measured lumbosacral angle).
Abbreviation: std, standard.
* Average cm.
† Average lb.

Table 3 Metabolic and hematologic blood serum values by time for those in the standing and nonstanding groups

Variables	Time 1 Intake, mean ± SD n=16	Time 1 Intake, mean ± SD Standers	Time 1 Intake, mean ± SD Nonstanders	12 mo, mean ± SD Standers	12 mo, mean ± SD Nonstanders	24 mo, mean ± SD Standers	24 mo, mean ± SD Nonstanders
Blood serum							
Calcium (mg/dL)	9.44±0.51	9.28±0.44 n=12	9.93±0.39 n=4	9.16±0.11 n=5	5.05±7.14 n=2	9.45±0.07 n=2	-
Phosphorus (mg/dL)	7.85±16.17	8.61±17.45 n=12	3.30±0.57 n=2	3.72±0.70 n=5	2.05±7.14 n=2	3.40±0.00 n=1	-
Hemoglobin (g/dL)	14.68±1.51	14.72±1.55 n=11	14.58±1.63 n=4	-	-	-	-
Prealbumin (mg/dL)	26.48±4.18	26.21±4.51 n=12	27.28±3.37 n=4	29.04±3.10 n=5	14.55±20.58 n=2	25.70±0.00 n=1	-
Alkaline phosphatase (IU/L)	92.88±38.44	93.42±44.28 n=12	91.25±13.82 n=4	91.00±34.56 n=5	39.50±55.89 n=2	65.00±0.00 n=1	-
Sodium (mEq/L)	140.08±3.42	140.78±2.64 n=9	138.00±5.29 n=3	-	-	-	-
Potassium (mmol/L)	4.36±0.38	4.32±0.38 n=9	4.47±0.46 n=3	-	-	-	-
Chloride (mEq/L)	103.08±2.84	103.60±2.50 n=10	101.33±3.79 n=3	-	-	-	-
CO_2 (mEq/L)	27.23±1.42	27.3±1.57 n=10	27.00±1.00 n=3	-	-	-	-
Anion gap (mEq/L)	8.80±1.79	8.75±2.06 n=4	9.00±0.00 n=1	-	-	-	-
VitD 25 OH (ng/mL)	41.53±14.27	41.65±13.47 n=10	41.13±20.15 n=3	41.62±5.18 n=5	10.00±14.14 n=2	48.00±0.00 n=1	-
T4 free (ng/dL)	1.15±0.30	1.11±0.32 n=10	1.25±0.24 n=4	1.03±0.16 n=5	-	0.95±0.21 n=2	-
TSH (mU/L)	2.33±1.14	2.39±1.15 n=9	2.21±1.28 n=4	1.75±0.87 n=4	-	11.02±0.00 n=1	-

Abbreviations: CO_2, carbon dioxide; TSH, thyroid-stimulating hormone; Vit, vitamin.

Table 4 Participant characteristics for those in the standing and nonstanding groups

Variables (n)	All participants (n=18)	Standers (n=13)	Nonstanders (n=5)
Previous orthopedic procedure	14	9	5
Previous spine surgery	7	5	2
Previous lower extremity bony surgery	9	6	3
Fracture history	3	2	1
Past spasticity treatment			
Botox	10	6	4
ITB	9	7	2
SDR	0	0	0
Transfers			
Hoyer lift	6	5	1
Ceiling tract	3	2	1
Transfer unit	1	1	0
Stand pivot	4	3	1
Other	4	2	2

Abbreviations: ITB, intrathecal baclofen; SDR, selective dorsal rhizotomy.

history of standing: 1 in the nonstanding group (by study group definition) and 3 in the standing group.

Table 5 displays mean values of measured bone mineral content and bone mineral density at the spine, hips, and distal femurs for standers and nonstanders. Time 1 (intake) values are recorded along with those at 12 and 24 months. Low bone mineral content and density were identified across all participants, with supplementation of vitamin D and calcium provided when possible. No appreciable differences were identified between standers and nonstanders at any of the measured points in time, including baseline. Difficulty in body positioning of the spine and extremities with contractures made gathering of the measured values only possible at certain sites and with certain individuals. The follow-up after baseline was extremely limited because of transportation and staffing issues from local and more rural community group homes. Only 3 people could be evaluated with DEXA scans from baseline and 24 months later.

Table 6 and figure 2 display measured values of bone mineral content and bone mineral density at the spine, hips, and distal femurs for standers and nonstanders of study participants with at least a 12-month follow-up measure. Because drop off of participants between baseline, 12, and 24 months was notable, this table was needed to identify any appreciable unrelated differences. Each row or line represents 1 patient. No identifiable differences could be appreciated.

Table 7 lists the number of participants in the standing group self-reporting improvement or negative effects from participation in their standing program. Only 1 individual reported a negative effect from standing described as fatigue particularly at the end of the day. No meaningful

Table 5 BMC and BMD measurements by site and time for those in the standing and nonstanding groups

Variables	Time 1 Intake, mean ± SD n=14	Time 1 Intake, mean ± SD Standers	Time 1 Intake, mean ± SD Nonstanders	12 mo, mean ± SD Standers	12 mo, mean ± SD Nonstanders	24 mo, mean ± SD Standers	24 mo, mean ± SD Nonstanders
DEXA							
Spine L1-L4		n=8	n=2	n=3	n=1	n=2	n=1
BMC (g)	42.37±6.26	42.20±4.99	43.03±13.30	43.96±6.43	56.62±0.00	41.15±4.14	55.56±0.00
BMD (g/cm^2)	0.87±0.16	0.88±0.12	0.86±0.29	0.94±0.04	0.83±0.00	0.93±0.05	0.87±0.00
Left hip		n=10	n=3	n=5	-	n=2	-
BMC (g)	20.43±7.59	22.64±5.72	13.06±9.62	23.51±5.66		21.85±6.89	
BMD (g/cm^2)	0.72±0.16	0.73±0.15	0.70±0.23	0.78±0.22		0.80±0.15	
Right hip		n=10	n=2	n=4	n=1	n=2	n=1
BMC (g)	23.65±6.62	23.58±6.65	24.00±9.14	21.64±5.68	27.34±0.00	21.66±10.01	25.00±0.00
BMD (g/cm^2)	0.67±0.20	0.66±0.20	0.72±0.30	0.66±0.13	0.76±0.00	0.79±0.16	0.67±0.00
Left distal femur		n=10	n=4	n=4	n=2	n=1	n=2
BMC (g)	4.07±1.47	3.94±0.73	4.40±2.76	3.98±1.24	3.48±1.90	2.35±0.00	3.51±2.43
BMD (g/cm^2)	0.63±0.14	0.64±0.15	0.59±0.10	0.61±0.14	0.49±0.63	0.80±0.00	0.52±0.001
Right distal femur		n=10	n=3	n=4	n=2	n=1	n=2
BMC (g)	2.92±0.82	3.17±0.70	2.06±0.66	3.38±1.86	7.51±0.71	2.80±0.00	6.13±0.49
BMD (g/cm^2)	0.63±0.16	0.65±0.16	0.56±0.12	0.50±0.21	0.65±0.21	0.71±0.00	0.60±0.15

Abbreviations: BMC, bone mineral content; BMD, bone mineral density.

Table 6 DEXA case summaries for study participants with at least a 12-month follow-up measure BMC/BMD

Group	Baseline	12 mo	24 mo	Group	Baseline	12 mo	24 mo
Spine BMC (g)				Spine BMD (g/cm^2)			
Standing	43.64	42.76	44.08	Standing	0.89	0.93	0.96
Standing	39.46	38.21	38.22	Standing	0.94	0.91	0.89
Standing	50.61	50.90		Standing	0.96	0.99	
Nonstanding	52.43	56.62	55.56	Nonstanding	0.78	0.83	0.87
L hip BMC (g)				L hip BMD (g/cm^2)			
Standing	15.72	15.69	16.98	Standing	0.68	0.69	0.70
Standing	26.60	26.75	26.72	Standing	0.88	0.90	0.91
Standing	28.55	30.47		Standing	1.03	1.10	
Standing	26.75	23.90		Standing	0.65	0.62	
Standing	19.73	20.73		Standing	0.54	0.58	
R hip BMC (g)				R hip BMD (g/cm^2)			
Standing	14.94	14.98	14.58	Standing	0.68	0.67	0.67
Standing	26.13	27.73	28.73	Standing	0.34	0.85	0.91
Standing	25.60	24.68		Nonstanding		0.76	0.67
Standing	18.30	19.18					
Nonstanding		27.34	25.00				
L DF BMC (g)				L DF BMD (g/cm^2)			
Group	Baseline	12 mo	24 mo	Group	Baseline	12 mo	24 mo
Standing	3.47	4.76	2.35	Standing	0.66	0.81	0.80
Standing	3.90	4.95		Standing	0.71	0.60	
Standing	2.70	2.22		Standing	0.46	0.48	
Standing	4.86	3.97		Standing	0.55	0.57	
Nonstanding	4.20	4.82	5.23	Nonstanding	0.71	0.54	0.52
Nonstanding	8.28	2.14	1.79	Nonstanding	0.52	0.45	0.52
R DF BMC (g)				R DF BMD (g/cm^2)			
Group	Baseline	12 mo	24 mo	Group	Baseline	12 mo	24 mo
Standing	2.95	1.14	2.86	Standing	0.77	0.21	0.71
Standing	2.01	2.78		Standing	0.50	0.48	
Standing	3.93	4.10		Standing	0.48	0.66	
Nonstanding		7.00	6.47	Nonstanding		0.80	0.71
Nonstanding	1.70	8.01	5.78	Nonstanding	0.48	0.50	0.49

Abbreviations: BMC, bone mineral content; BMD, bone mineral density; DF, distal femur; L, left, R, right.

differences were identified, including at baseline, between the standing and nonstanding groups with respect to head control, urinary continence, range of motion at the hips and knees, or perceived pain as measured on the visual analog pain scale or the Canadian Physiotherapy Association 11-Point Pain Scale. The occurrence of functional head control >30 seconds in the midline was documented only in the standing group.

Discussion

Use of a standing frame support as part of the postural management of nonambulant young children with CP is a commonly prescribed therapy participation among rehabilitation medicine professionals. Despite this common practice, little science is available to demonstrate cause and effect between standing exercises and perceived benefits that include improvements in bowel care, bone density, range of motion, pulmonary functions, and quality of life.[7-12] The present study, to our knowledge, is the first in the literature on nonambulatory adults with CP (GMFCS level V) that attempts to compare those who stand vs those who do not. No appreciable differences or occurrences were identified in this study between these 2 groups of adults with respect to both static variables and perceived benefits evaluated. This includes no differences in data measured at enrollment between individuals in the standing group who had been standing for at least 2 years prior to study entry compared with peers who had not. There may be reasons for the lack of differences identified between the standing and nonstanding groups, the most important being the low number of participants involved at baseline, further reduced by dropouts at follow-up. As mentioned previously, follow-up was very difficult, with many participants unable to complete bone densitometry measures and laboratory blood draws at 12 and 24 months because of transportation and staffing issues from rural community group homes. In addition, our control group was small in number, with n=7 at baseline and n=5 on follow-up. Other possible reasons for lack of differences between groups may include relative low frequency of standing episodes on a weekly basis, low total duration of standing, and factors affecting true actual loading and weight borne by the lower extremities in passive standers.[13-15] In our opinion, and supported somewhat by the literature, it would seem that more notable changes in

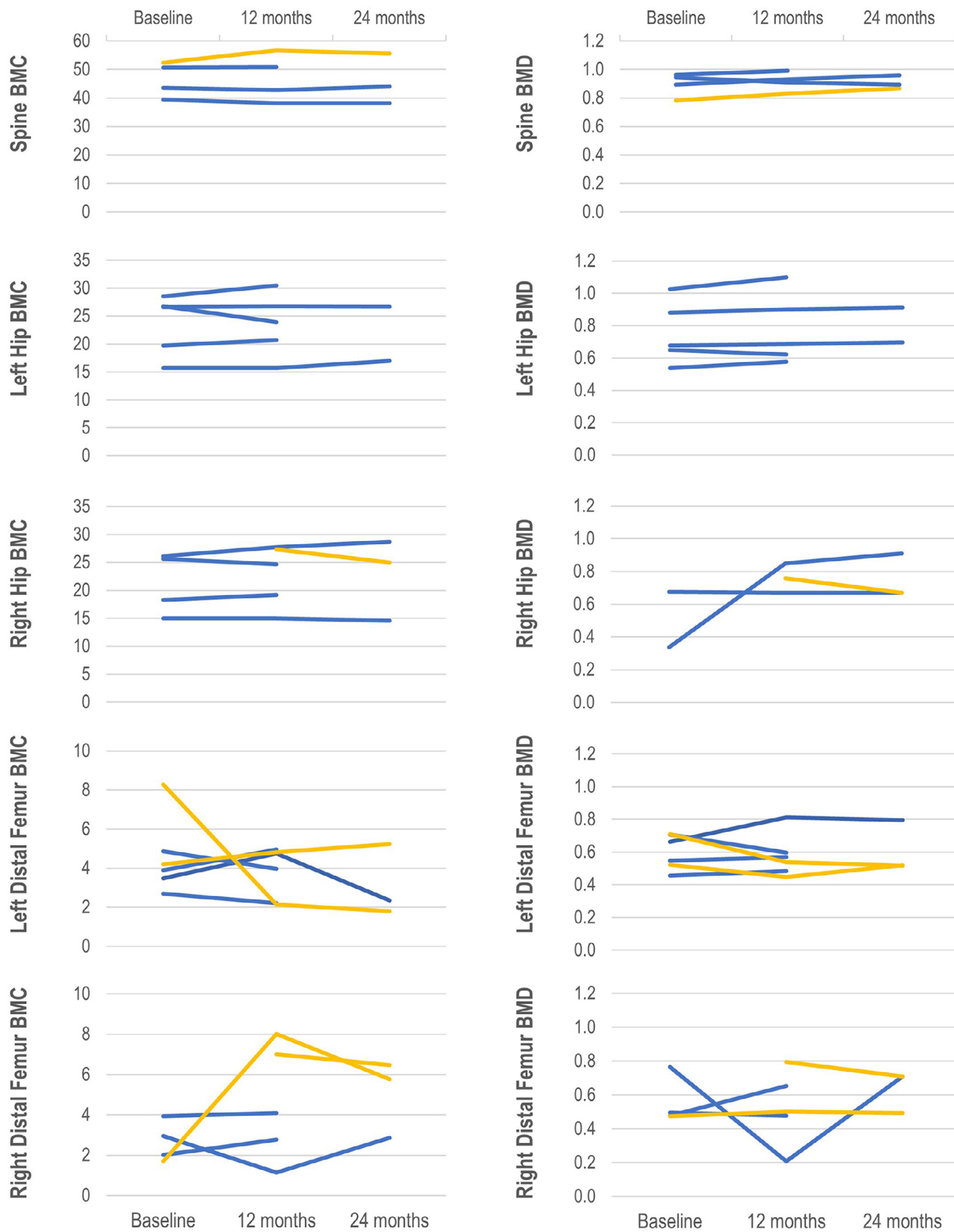

Fig 2 DEXA case summaries for study participants with at least a 12-month follow-up measure. Abbreviations: BMC, bone mineral content; BMD, bone mineral density.

static standing outcome variables would require more intensive daily standing both on the basis of frequency and total duration of true weight bearing.[13] Such high-intensity standing programs on a day-to-day basis would seem to be beyond the capability of many busy families with other competing obligations and basic necessities requiring attention. The study did show that participants in the standing group reported perceived benefits, with just 1 individual identifying the negative effect of fatigue associated with standing at the end of the day. This finding seems consistent with the literature[7] and needs to be seriously considered when prescribing individual standing exercise programs. A standing program should consider a multitude of variables, including effects on social and vocational participation, fatigue, pain, and expense prior to therapeutic onset. A more recent trend in the literature appears to suggest some association with gross motor functions and people with CP performing regular standing exercises.[9,10,16] Gibson et al[17] studied a convenience sample of nonambulant children with CP and reported easier transfers and performance of activities of

Table 7 Health-related outcomes related to participation in a standing program

Outcomes	Participants reporting improvement (n) (n=11)	Participants reporting negative effects (n) (n=10)
Bowel/bladder function	5	0
Well-being	9	0
Digestion	7	0
Self-care	1	0
Pain	2	0
Sleep patterns	5	0
Circulation	8	0
Fatigue	2	1
Breathing	5	0
Spasticity	5	0
Skin sores	3	0

daily living from care providers after standing frame use. Nelson et al[18] noted a small increase in work output in an individual with CP depending on positioning in the standing table equipment. Unger et al[19] found an increase in the number of sit-ups a participant could perform with whole body vibration standing, whereas Alborg[20] and Ruck[21] and colleagues found associated improvements with sitting and crawling. The present study did identify occurrences in functional standing pivot transfers in only those individuals who were performing standing on a regular basis. Functional head control >30 seconds in the midline occurring with FIM scores >55 were seen only in the standing group. These occurrences would seem at least consistent with the associated improvements in gross motor function identified in the literature previously cited. In our opinion future studies on nonambulatory individuals with CP across the life span performing standing exercises might best include associated gross motor outcome variables that are practical, easily measured, and functional to the daily living environment. Functional standing pivot transfers is 1 outcome variable that would be of interest and may be associated with regular episodes of standing in people with CP over the life span. The value of a functional stand pivot transfer across the life span is hard to overestimate with the elimination of expensive equipment such as Hoyer lifts, ceiling tracts, and less risk of back pain with additional trauma to care attendants providing more physical assist. Further studies in this regard are encouraged with hopeful benefit to people with CP, their functional abilities, and their daily participations.

Study limitations

The primary limitations of this study are the small number of participants and the high drop out rate of individual participants over the 2-year study period. Bone density was most difficult to measure in our study population, with many participants having limiting joint contractures at the hips and knees. Finally, the posture in standing for each participant was very different as was his or her individual standing table equipment.

Conclusions

The population of adults with CP is growing in number and requires notice by the adult physiatrist and rehabilitation team. Our pilot study of nonambulatory adults with CP, those who stand vs those who do not, identified no differences in measured nonfunctional variables, including bone density. Occurrences of mention included the maintenance of a standing pivot transfer over the life span in only those adults who had a history of standing. The benefit of a functional standing pivot transfer over one's lifetime is difficult to overestimate. Further studies on the benefit of daily standing exercise might consider focusing more on outcome variables related to function, including head and upper trunk control.

Supplier

a. QDR x-ray bone densitometer; Hologic Inc.

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