Aging in Cerebral Palsy

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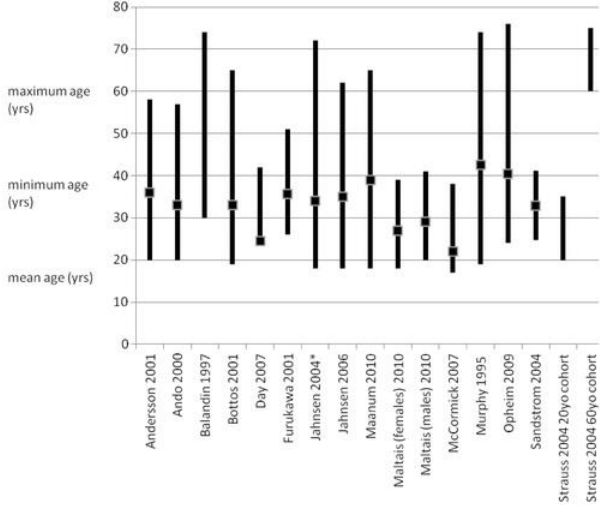
이상지

Aging in cerebral palsy



- Evolution of the motor disorder as the individual moves through

  adolescence,
  young adulthood,
  middle age,
  and old age is not well understood.

- although brain injury that causes CP by definition does not progressively worsen through the lifetime
- effects of CP manifest differently throughout the lifespan

Aging in cerebral palsy

- evolution of **motor** disorders in CP in adult life?
- **associated problems**
  swallowing, respiration and voiding
- **quality of life** for adults with CP
  pain
  psychologic problems
- Adult CP clinic, **transition**

Cerebral palsy and aging
Dev Med Child Neurol
2009 Oct;51 Suppl 4(0 4):16-23.

premature aging

- adults with CP who have impaired gait develop secondary conditions of the musculoskeletal system
- 25% adults will experience a decline or loss of walking ability
- higher risk of gait decline are those with worse initial gait ability

Gait function and decline in adults with cerebral palsy: a systematic review
Disabil Rehabil . 2014;36(1):1-9

Ann Rehabil Med 2019;43(3):241-249
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arm
Annals of Rehabilitation Medicine

Emerging Issues in Cerebral Palsy Associated With Aging: A Physiatrist Perspective

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The population of adults diagnosed with cerebral palsy (CP) is increasing along with the survival rate of children born with the disability. Adults with CP need health services for the continued monitoring and management of their condition. Moreover, the development of additional health problems in adulthood increases the need for ongoing access to health services. Adults with CP manifest a higher rate of chronic health conditions and eventual decline in strength and functional reserve, deterioration in physical activity, increased risk of musculoskeletal complications, and gradual changes in swallowing ability. They are also reported to exhibit difficulty engaging socially and have a low health-related quality of life (QOL). However, there are a large number of adults with CP who cannot access medical services adequately and are therefore not effectively treated. To overcome these apparent challenges, we need to fully comprehend the healthcare needs of adults with CP to develop adult-focused health services. Further research is needed regarding the impact of physical activity, nutrition, sarcopenia, myeloradiculopathy, and swallowing function on QOL.

Keywords Cerebral palsy, Adult, Quality of life, Deterioration

Adults with cerebral palsy: a workshop to define the challenges of treating and preventing secondary musculoskeletal and neuromuscular complications in this rapidly growing population

- How is the **natural history of musculoskeletal impairments** level, subtype, and impairments?
- What is the age-specific and type-of-CP-specific prevalence of **secondary musculoskeletal conditions** in individuals with CP? Are any of these conditions preventable or treatable?
- What is the **etiology and prevalence of pain** in adults with CP? How can pain and chronic fatigue be prevented and managed in these individuals?
- Do persons with CP experience pain and **chronic fatigue** earlier or more frequently than their peers?
- What is the relationship between pain and **spasticity** as persons with CP grow older?
- What is the relationship between **type of CP** to location, severity, duration, and age at onset of **pain**?

Developmental Medicine & Child Neurology 2009, 51 (Suppl. 4): 2–11

- Is there evidence that the **muscular deficits** in childhood coupled with the natural history of **sarcopenia** and atrophy in adulthood, contribute to early loss of strength and mobility in the adult with CP?
- Do weight bearing and activity lead to early **arthritis** in the person with CP? If so, how can it be prevented?
- Does decreased muscle mass lead to an increased incidence of **metabolic syndrome** and **cardiovascular complications** in adults with CP?
- Are the factors that contribute to **osteoporosis** in adults with CP different from those that cause osteoporosis the general population? What impact would such differences have on screening and interventions?

Developmental Medicine & Child Neurology 2009, 51 (Suppl. 4): 2–11

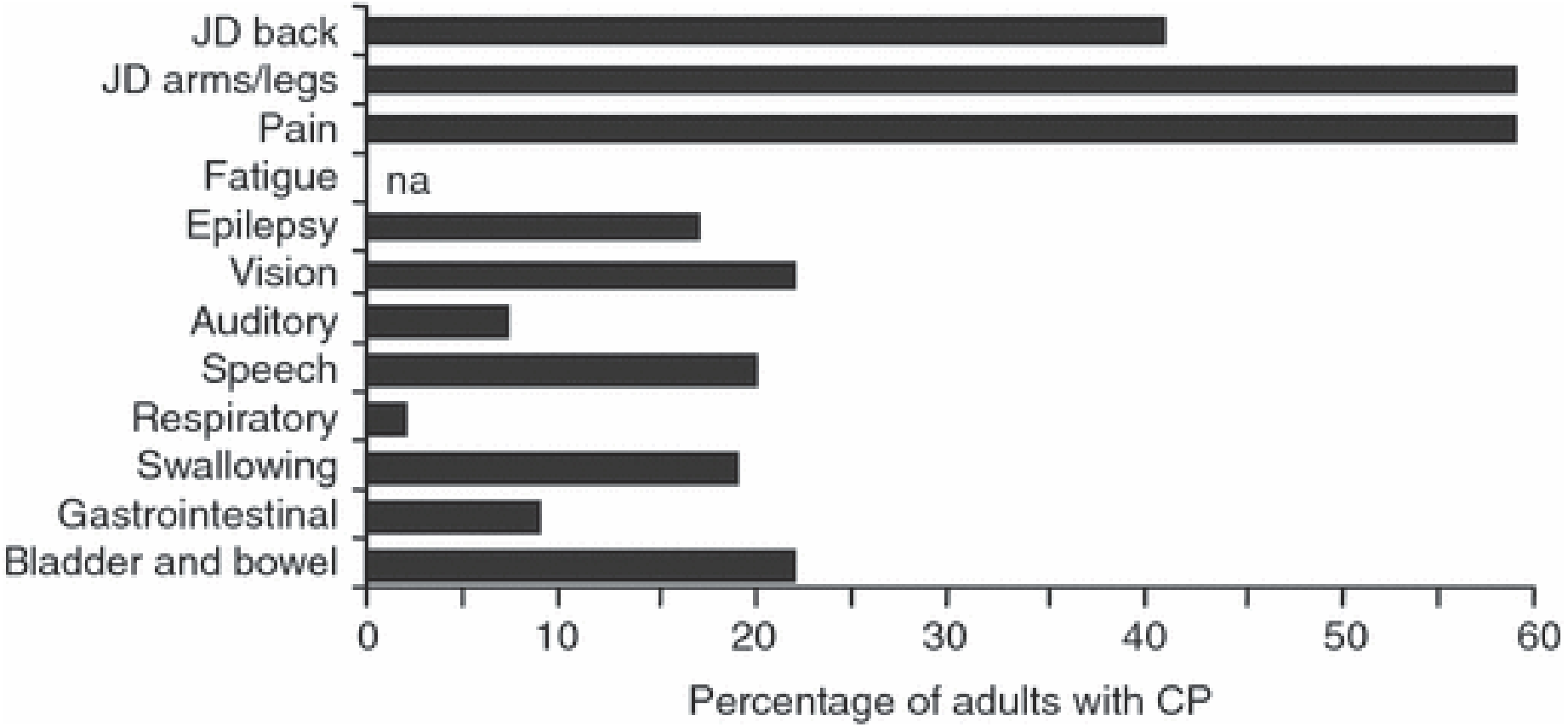
- What is the evidence for **accelerated aging** in persons with CP?
- What is the physiology of this process?
- What **risk factors** can cause the manifestation of aging to vary for persons with CP?
- Should **health maintenance services** be different for persons who have prematurely aged than for those who have not?
- What **age-related changes** are unaffected by CP?
- What is the **prevalence of early loss of mobility**, early onset of osteoarthritis, osteoporosis ⁄ fragility fractures,
- **worsening spasticity and dystonia** in adults with CP? How can these conditions be delayed, prevented, and managed?

Developmental Medicine & Child Neurology 2009, 51 (Suppl. 4): 2–11

- How does physical activity contribute to the lives of adults with CP?
- What types of physical activity (strengthening, aerobic, flexibility, aquatic), combinations of activity, and doses of exercise and activity are most effective for specific disabilities and secondary conditions?
- What **physiological parameters** provide the most reliable information needed to discern fitness need and decline or improvement?
- How effective are programs that train strength and aerobic capacity at the same time?

Developmental Medicine & Child Neurology 2009, 51 (Suppl. 4): 2–11

Health issues in 54 adults with cerebral palsy (CP): prevalence of impairments



Spasticity, spasm, dystonia

Dysphagia, Nutrition, GE reflux

Voiding problem

Psychologic problem, dementia

Respiratory problem, sleep apnea

Vision & hearing

Gait, ADL function

Sarcopenia, osteoporosis

Pain, Fatigue

Metabolic, degenerative disease

Cancer, poor medical surveillance

Family problem

Survival and mortality in cerebral palsy:

- persons born in Western Australia 1956-2011, registered with cerebral palsy on the Western Australian Register of Developmental Anomalies
- Mortality increased with increasing severity of impairment

- 58.6% respiratory causes
- 49% to pneumonia at a mean age of 14.6 (sd 13.4)
- 45% were attributed to aspiration

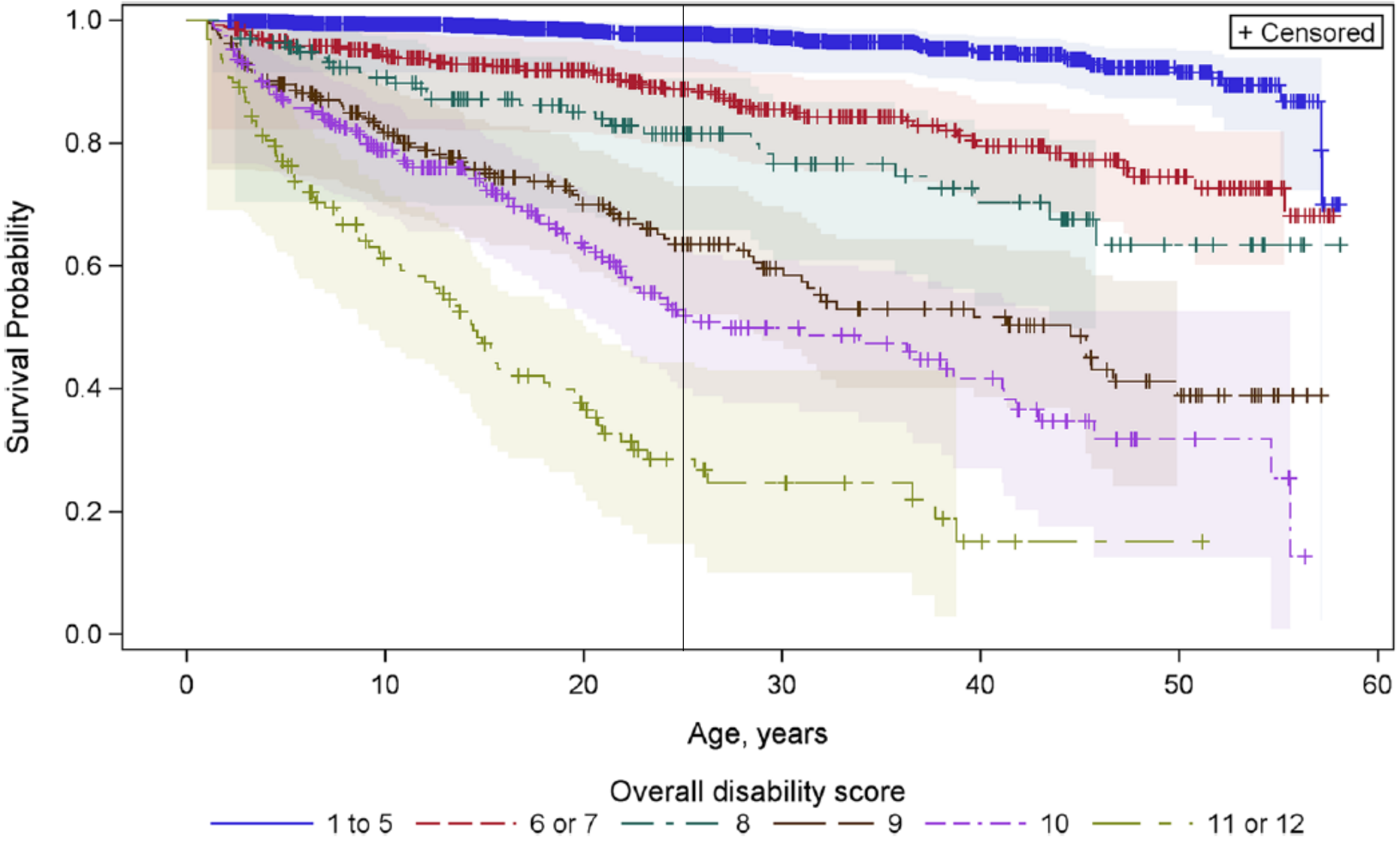
BMC Neurol
. 2019 Jun 4;19(1):111

overall disability score (0-12)

- **extent of impairment**
  1 (unilateral), 2 (bilateral) predominantly lower limb) or
  3 (bilateral other)
- **severity of impairment** of the most impaired body part
  0 (minimal),1 (mild), 2 (moderate) or 3 (severe)
- **cognitive** impairment
  0, 1 (~IQ 50–69), 2 (~ 35–49) or 3 (< 35)
- active **epilepsy** (0, 1)
- bilateral **blindness** (0, 1)
- bilateral **deafness** (0, 1)

BMC Neurol
. 2019 Jun 4;19(1):111

Survival curve by "overall disability score"



Estimated remaining life expectancy in years by age and overall disability stratum

Lower limit of age stratum, years	Overall disability score > =9 Remaining life expectancy, years	Overall disability score 6–8 Remaining life expectancy, years
1	33.2	59.3
5	34.6	57.5
15	31.9	50.5
25	30.4	42.7
35	24.2	34.9
50	16.2	24.0

Blair *et al. BMC Neurology* (2019) 19:111

Table 3 Distribution of causes of death with associated characteristics of overall disability score (DISAB) and duration

Coded Cause of death	Total % (N)	Mean DISAB(sd)	Median DISAB	N with missing DISAB	Mean age of death years (sd)	Median age of death, years
Respiratory	56.8 (187)	9.3 (1.9)	10	2	15.0 (12.6)	12.1
No sufficient immediate cause coded	7.3 (24)	8.3 (3.0)	9.5	0	23.7 (16.8)	21.1
Status epilepticus	6.7 (22)	7.4 (2.5)	7.5	0	9.4 (9.2)	6.1
Accident/trauma	6.4 (21)	6.1 (2.4)	6	0	22.5 (14.1)	21.3
Non-respiratory infection	4.9 (16)	8.5 (2.7)	10	1	16.6 (15.9)	11.5
Cancer	4.0 (13)	6.1 (2.35)	6	0	37.7 (14.5)	36.6
Circulatory disease	3.6 (12)	7.5 (2.4)	7	1	28.4 (17.9)	24.0
Major organ failure	3.0 (10)	6.5 (2.8)	6	0	26.8 (16.5)	25.9
> 1 sufficient cause	3.0 (10)	8.6 (2.9)	9	1	23.2 (6.3)	25.0
Miscellaneous	2.7 (9)	9.6 (1.8)	10	0	15.5 (9.8)	14.0
Birth defects	1.5 (5)	7.4 (3.6)	9	0	14.6 (18.2)	5.5
Total with cause	100 (329)	8.6 (2.4)	9	5	17.8 (14.7)	14.3
	N					
Unknown cause	107	8.1 (2.6)	9	85	11.6 (10.2)	7.9
Total deaths	436	8.5 (2.5)	9	90	16.3 (14.0)	12.5
					Mean age at census	Median age at census
Survivors	2749	4.6 (2.5)	4	111	25.6 (15.0)	23.4

Mortality from respiratory problem

- aspiration & oropharyngeal dysfunction and resulting pneumonia as important factors
- risk factors predicting respiratory hospital admissions in CP
  - Seizures
  - gastro-oesophageal reflux disease
  - previous respiratory symptoms particularly those necessitating hospitalization or antibiotic use
  - But not scoliosis

Respiratory morbidity

- GMFCS level 5
- dysphagia
- cough impairment
- gastroesophageal reflux (GOR)
- kyphoscoliosis
- upper airway obstruction
- sleep disordered breathing
- epilepsy
- medication adverse events
- malnutrition

Paediatr Respir Rev.
2020 Feb;33:16-23

Risk factors for respiratory hospital admissions for young people (1-26 years) with cerebral palsy

Risk checklist: https:www.abilitycentre.com.au/resources/cpchecklist/

Red Flags

Gross Motor Function Classification System (GMFCS) Level V

IRR* = 23.25 (95% CI: 10.46 to 51.70)

At least one respiratory hospital admission in the last year

IRR* = 11.8 (95% CI: 5.6 to 24.7)

At least 2 courses of antibiotics for respiratory illness in the last year

IRR* = 5.9 (95% CI: 3.0 to 11.6)

Potentially Modifiable Risk Factors

Oropharyngeal dysphagia
(requires foods or drinks with modified texture OR uses a tube OR coughs or chokes on saliva)

IRR* = 12.7 (95% CI: 7.3 to 22.1)

Frequent respiratory symptoms
(daily cough or weekly sounding sound chesty or phlegmy or wheezy)

IRR* = 9.4 (95% CI: 3.5 to 25.8)

Current seizures

IRR* = 7.6 (95% CI: 4.2 to 13.8)

Gastro-oesophageal reflux disease
(now or previously)

IRR* = 3.4 (95% CI: 1.8 to 6.3)

Mealtime respiratory symptoms when well
(gurgly voice, wheezing, coughing, sneezing, choking)

IRR = 3.8 (95% CI: 2.1 to 7.1)

Snoring every night

IRR* = 2.8 (95% CI: 1.3 to 6.1)

* IRR (Incidence Rate Ratio) indicates the expected magnitude of the respiratory hospital admission rate over a 5-year period when the risk factor is present versus when it is absent. E.g., Young people with CP classified as GMFCS V are expected to have a respiratory hospital admission rate about 23 times greater than those classified GMFCS I to IV over a 5-year period.

Blackmore AM, Bear N, Langdon K, Moshovis L, Gibson N, Wilson AC. Respiratory hospital admissions and emergency department visits in young people with cerebral palsy: 5-year follow-up. Archives of Disease in Childhood 2019; 45: 745-771.

https://adc.bmj.com/content/early/2019/06/29/archdischild-2019-317714

Preventive respiratory management during transition

- airway clearance techniques should be reviewed, including considerations of efficacy and safety
- high-frequency chest wall oscillation devices may have the added benefit of improved adherence to therapy
- Positive expiratory pressure (PEP) treatment can be beneficial amongst patients with sufficient cognition and coordination
- young people unable to perform manual PEP treatment may instead benefit from PEP via non-invasive ventilation (NIV)

Pneumonia prevention strategies for children with neurologic impairment

- Only **dental care** was associated with decreased risk of subsequent pneumonia hospitalization (adjusted odds ratio [aOR]: 0.64; 95% confidence interval [CI]: 0.49–0.85). Exposures associated with increased risk included new gastrostomy tube placement (aOR: 2.15; 95% CI: 1.63–2.85), chest physiotherapy (aOR: 2.03; 95% CI: 1.29–3.20), outpatient antibiotics before hospitalization (aOR: 1.42; 95% CI: 1.06–1.92), clinic visit before (aOR: 1.30; 95% CI: 1.11–1.52), and after index hospitalization (aOR: 1.72; 95% CI: 1.35–2.20)

Pediatrics, 144 (2019), 10.1542/peds.2019-0543

Clinical and Pulmonary Function Markers of Respiratory Exacerbation Risk in Subjects With Quadriplegic Cerebral Palsy

- frequent exacerbators (ie, ≥ 2 exacerbations) and infrequent exacerbators (ie, < 2 exacerbations)
- **gastroesophageal reflux** (adjusted odds ratio of 23.95 for subjects with confirmed diagnosis, P = .02)
- higher PaCO2 levels (adjusted odds ratio of 12.60 for **every 5-mm Hg increase in PaCO2**, P = .05). Subjects with **PaCO2 ≥ 35 mm Hg** showed an exacerbation odds ratio of 15.2 (95% CI 1.5–152.5, P = .01).

Respiratory Care October 2015, 60 (10) 1431-1437

Parameter	All Subjects	Frequent Exacerbators	Infrequent Exacerbators	*P*
pH	7.48 ± 0.06	7.48 ± 0.06	7.47 ± 0.07	.83*
P_{aO_2}, mm Hg	81 ± 24	75 ± 22	86 ± 24	.2*
P_{aCO_2}, mm Hg	33 ± 5	35 ± 6	31 ± 3	.04*
S_{aO_2}, %	95 ± 4	94 ± 4	96 ± 4	.2†
Interrupter technique, cm H_2O/L/s				
Inspiratory airway resistance	13.97 ± 5.71	13.76 ± 6.22	14.07 ± 5.40	.89*
Expiratory airway resistance	12.85 ± 4.28	13.15 ± 5.20	12.64 ± 3.67	.7*
SDB, *n* (%)	10 (32.1)	3 (21.4)	7 (41.2)	.28‡

Data are expressed as mean ± SD unless indicated otherwise.
* Student *t* test, Satterthwaite method for unequal variance.
† Wilcoxon rank-sum test.
‡ Fisher exact test.
S_{aO_2} = arterial oxygen saturation.
SDB = sleep-disordered breathing.

Variable	Odds Ratio	95% CI	*P*	Adjusted Odds Ratio*	95% CI	*P*
Gastroesophageal reflux	5.63	0.92–34.57	.09†	23.95	1.58–363.86	.02
P_{aCO_2} (Δ = 5 mm Hg)	3.10	0.92–10.39	.07	12.60	1.03–154.33	.05
Airway mucous encumbrance	4.58	0.99–21.12	.07†	7.26	0.38–137.44	.18

* Controlled for age and sex.
† Fisher exact test.

Obstructive sleep apnea in children with cerebral palsy

- greater risk of OSA due in part to the abnormalities of upper airway tone
  - laryngeal dystonia
  - severe laryngomalacia due to reduced tone in the supraglottic structures
  - concurrent pseudobulbar palsy
- 65% of children with epilepsy were determined to be at risk of OSA using Pediatric Sleep Questionnaire (PSQ)
- Desaturation at sleep

Cervical Myelopathy in Patients with Cerebral Palsy: 12 case series

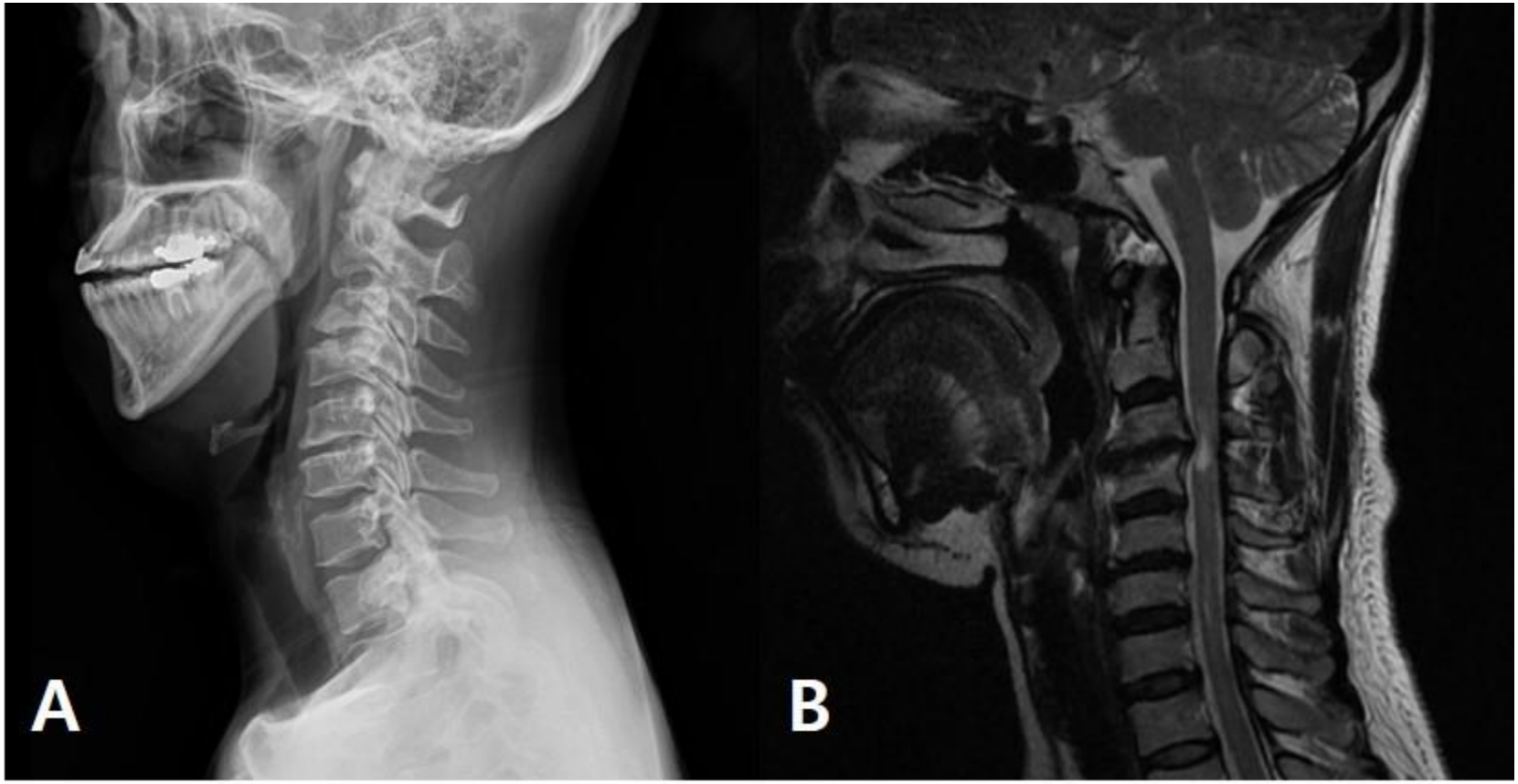


Figure 1. C3-C6 vertebral body flattening and C3-4 disc space narrowing in A, and central stenosis with indentation with signal change in C3-4 spinal cord B

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Table 2. Number of abnormal findings of preoperative cervical imaging interpreted by radiologist

	C0-1	C1-2	C2-3	C3-4	C4-5	C5-6	C6-7	C7-T1
Disc herniation	0	0	3	11	11	11	12	6
Instability	1	3	0	1	1	0	0	0
Spinal stenosis	0	1	4	9	8	8	8	6
Osteoarthritis of facet joints	0	0	7	7	7	6	6	2
Findings related to myelopathy [a)]	0	0	1	6	4	5	3	2

[a)] Findings related to myelopathy : Spinal cord compression, i ntramedullary T2 signal hyperin tensity, spinal cord edema

- Compared with cervical spondylotic myelopathy upon aging, anatomical findings of cervical spine in CP with CM showed common abnormalities in upper cervical segments and progress earlier in their lifetime. Repetitive axial rotation or lateral bending caused by neck writhing movement of CP patients could develop these anatomical abnormalities. Diagnosis of CM in CP patients is delayed because underlying neurologic problems conceal newly developed symptoms from myelopathy. Therefore, national screening system of CM in CP patients is necessary, and regular neurological examination and electrodiagnostic tests such as somatosensory evoked potential could be available.

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Walking function, pain, and fatigue in adults with cerebral palsy: a 7-year follow-up study

- walking function
  52% reported deterioration since debut of walking
  39% 7 years previously
- 71% bilateral CP, 31% unilateral CP reported deteriorated walking
- Participants with deteriorated walking function had
  greater pain freq(Short Form 36 domain bodily pain)
  pain intensity
  impact of pain on daily activities
  physical fatigue (Fatigue Questionnaire, Fatigue Severity Scale)
  reduced balance
- Reporting overall mobility problems was almost double

Dev Med Child Neurol, 51 (2009), pp. 381-388

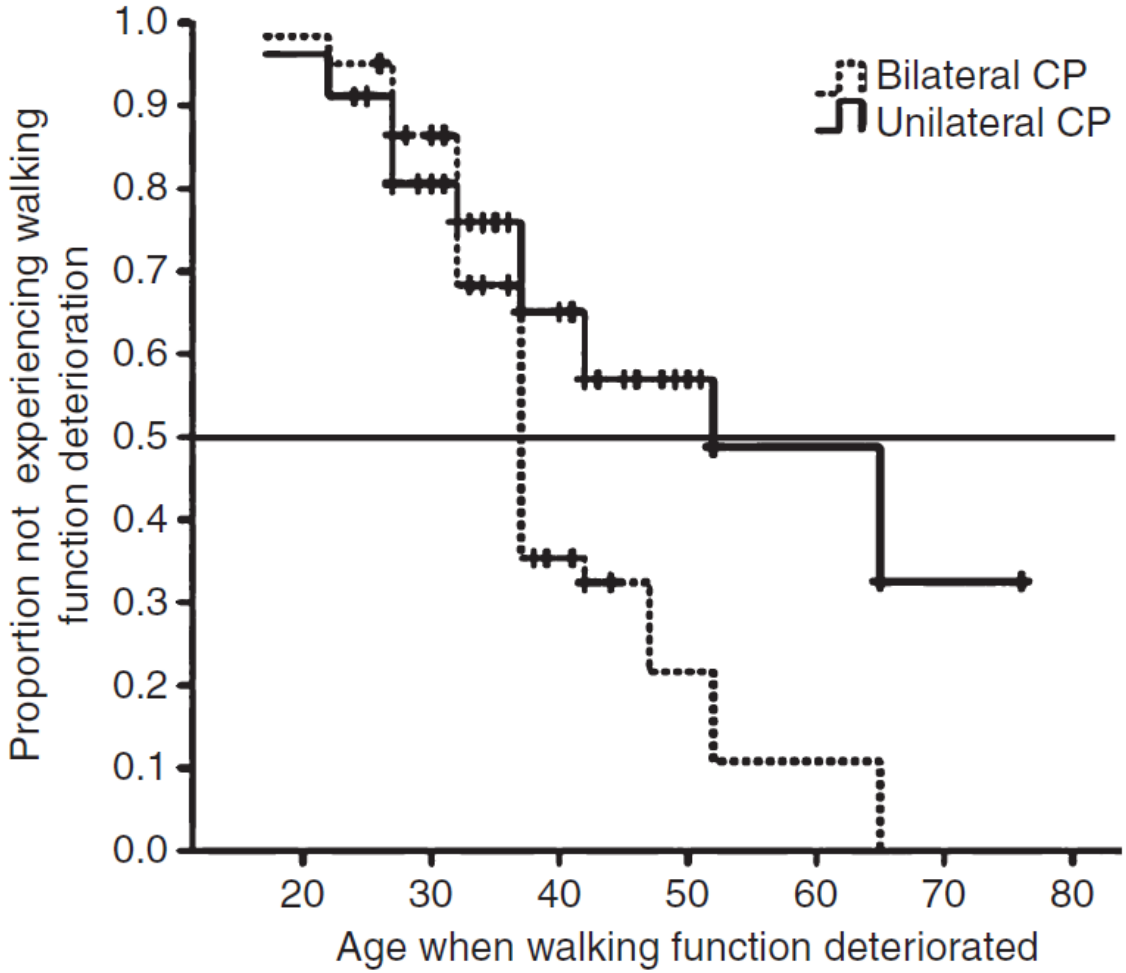
Walking function, pain, and fatigue in adults with cerebral palsy: a 7-year follow-up study

Table II: Gross Motor Function Classification System (GMFCS) levels of the present respondents compared with those in the original study by Jahnsen[5]

age 40y 5mo, SD 10y 7mo, range 24–76y

		GMFCS 1999					
		Level I	Level II	Level III	Level IV	Level V	Total
Unilateral cerebral palsy (n=81)							
GMFCS level 2006	I	**48**	5 (+)	-	-	-	53
	II	11 (-)	**4**	1 (+)	-	-	16
	III	2 (–)	-	**3**	-	-	5
	IV	-	1 (–)	1 (-)	**3**	-	5
	V	-	-	-	2 (-)	-	2
	Total	61	10	5	5	-	
Bilateral cerebral palsy (n=68)							
GMFCS level 2006	I	**8**	7 (+)	-	-	-	15
	II	9 (-)	**9**	1 (+)	1 (++)	-	20
	III	-	2 (-)	**16**	-	-	18
	IV	-	-	9 (-)	**5**	-	14
	V	-	-	-	1 (-)	-	1
	Total	17	18	26	7	-	

Numbers in bold are the number of persons with the same GMFCS level in 1999 and 2006. (+) and (++) indicate an improvement in gross motor function corresponding to a shift of one (+) or two (++) GMFCS levels; (-) and (–) indicate a deterioration in gross motor function corresponding to a shift of one (-) or two (–) GMFCS levels.

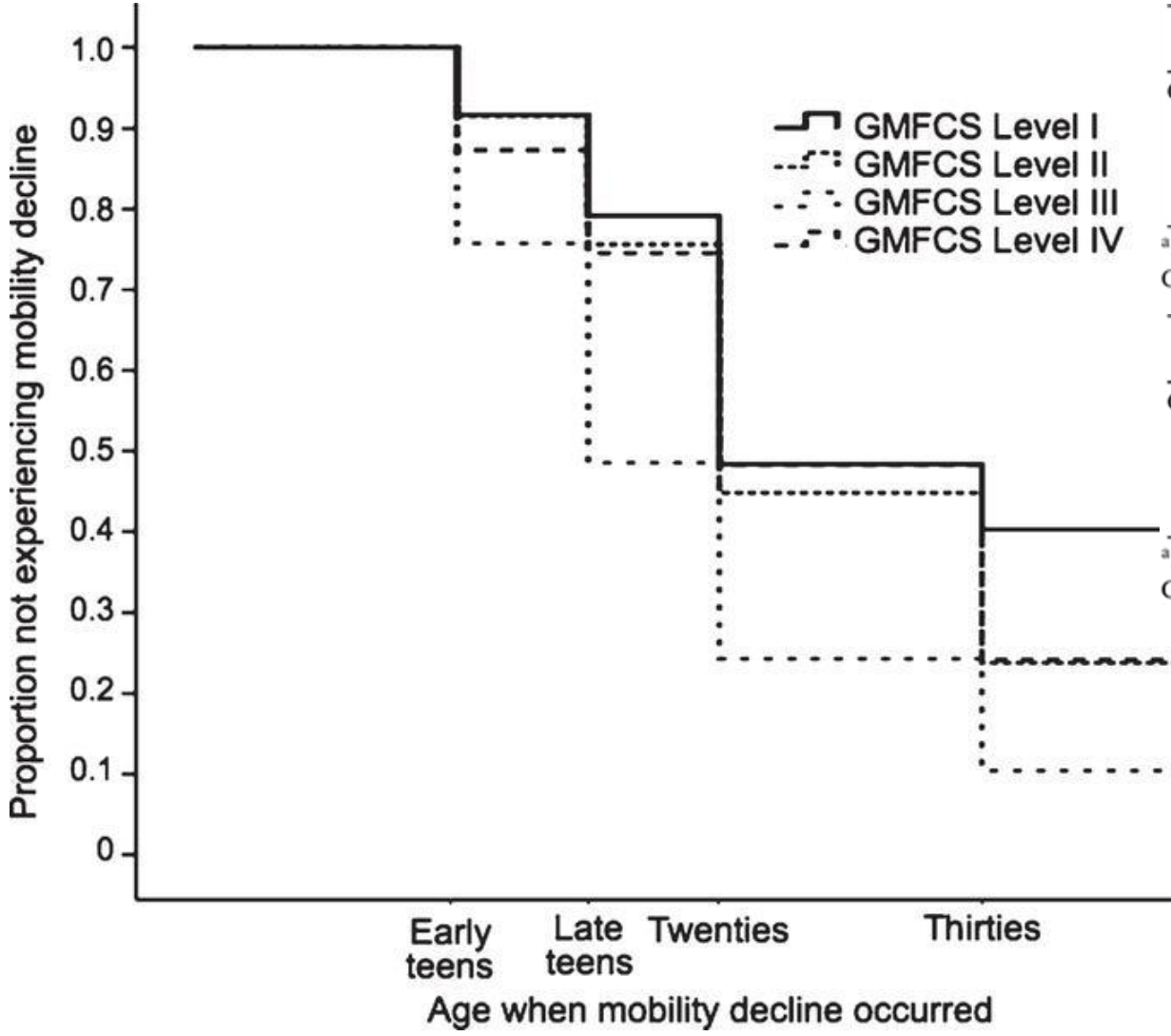


Kaplan-Meier plot of the proportion of persons not experiencing a deteriorated walking function in adults with unilateral and bilateral CP. Vertical tic marks indicate where data have been censored.

Dev Med Child Neurol, 51 (2009), pp. 381-388

Change in mobility function and its causes in adults with cerebral palsy by GFMCS level

: A cross-sectional questionnaire study



	Univariate analysis		
	HR	95%CI	*p*
GMFCS			
Level I	ref		
Level II	1.164	0.742–1.828	0.509
Level III	2.029	1.266–3.254	0.003
Level IV	1.146	0.730–1.825	0.566

[a]Multivariate analyses were adjusted for age, sex, respondent, N
CI, confidence interval; GMFCS, Gross Motor Function Classifica

	Multivariate analysis[a]		
	HR	95%CI	*p*
GMFCS			
Level I	ref		
Level II	1.165	0.730–1.858	0.522
Level III	1.972	1.203–3.234	0.007
Level IV	1.105	0.678–1.800	0.690

[a]Multivariate analysing notebook and surgery. HR, hazard ratio;
CI, confidence interon System.

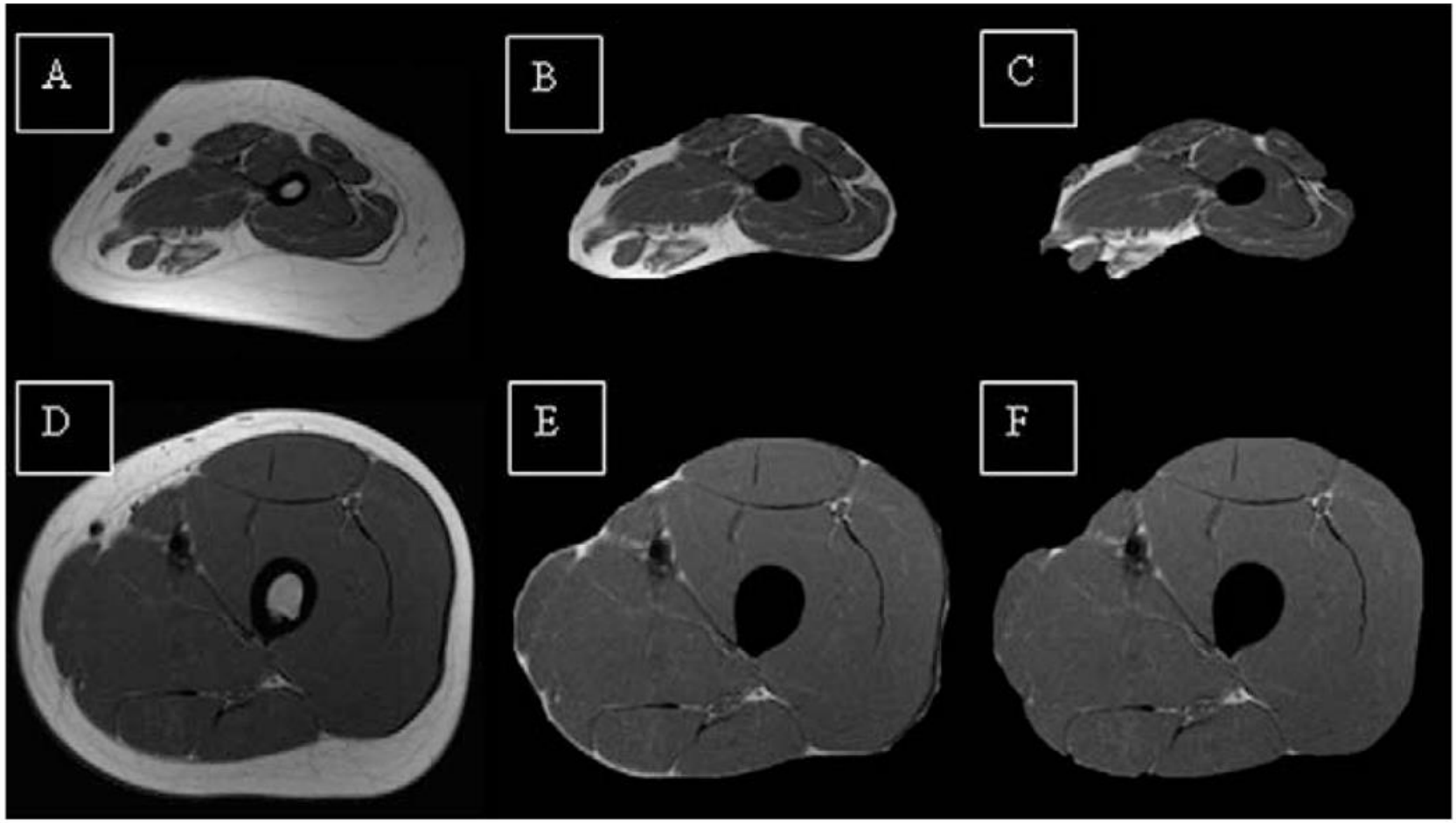
Self-reported cause of mobility decline

	GMFCS					
	Total* (n = 201)	Level I (n = 13)	Level II (n = 75)	Level III (n = 55)	Level IV (n = 58)	p
Change in Physique	28	0	8	8	12	0.062
Work	11	2	5	2	2	0.788
Change in environment	24	2	5	10	7	0.030
Reduced rehabilitation	17	2	6	4	5	0.970
Stress psychological problems	5	0	4	0	1	0.204
Illness and injury	21	0	5	11	5	0.001
Stiffness and deformity	24	1	5	4	14	0.023
Pain	12	1	8	1	2	0.166
Reduced m strength & cardiorespiratory function	12	3	3	3	3	0.587
Reduced physical activity	30	1	16	10	3	0.004
Aging	4	1	2	1	0	0.589
Change in mobility tools	8	0	3	1	4	0.521
Falls	5	0	5	0	0	0.029

Causes of the decline in mobility function

- pain
- fatigue
- lack of physical activity
- reduced balance
- decreased lower extremity strength

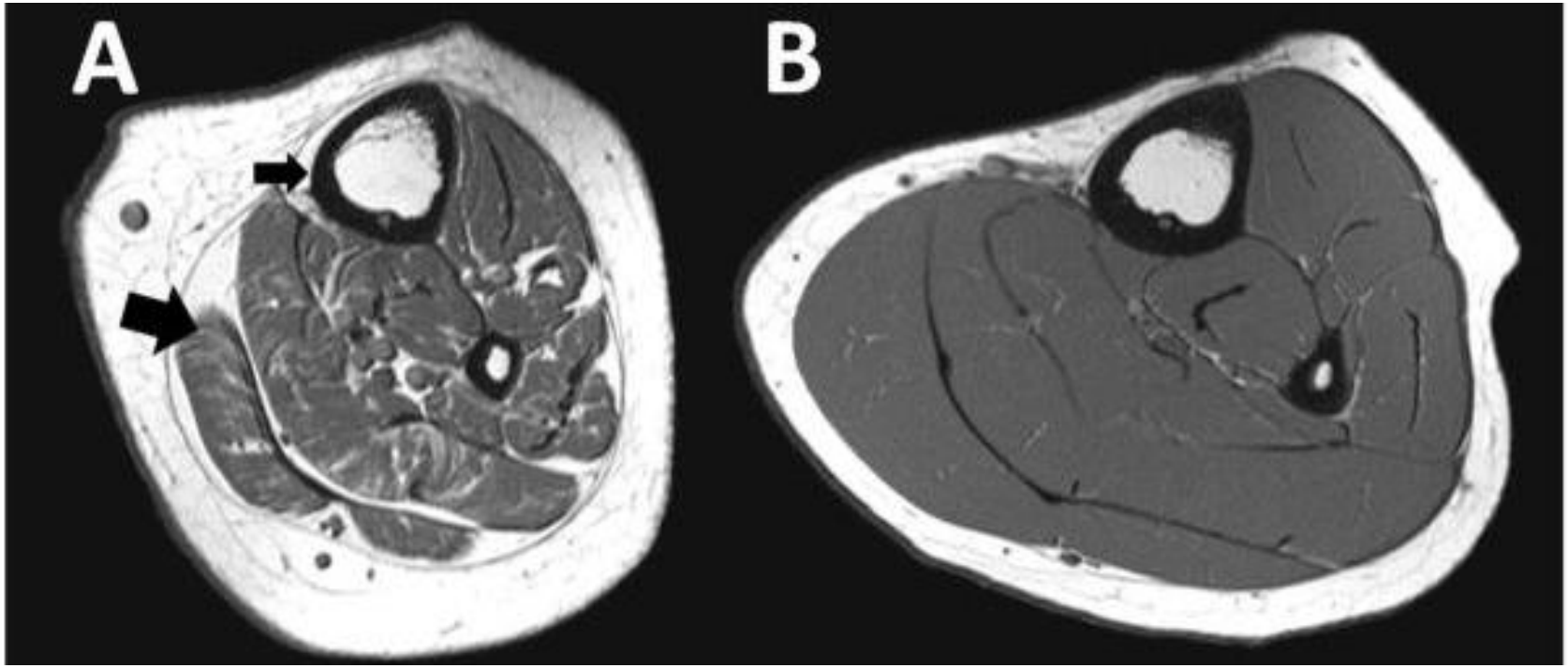
Adipose Tissue Infiltration of Skeletal Muscle in Children with Quadriplegic CP



A-C, The progressive separation of AT(adipose tissue) from magnetic resonance images of the midthigh of a prepubertal girl with QCP and D–F, a typically developing prepubertal girl. A and D contain subcutaneous, subfascial, and intermuscular AT; B and E contain only subfascial and intermuscular AT; and C and F contain only intermuscular AT. J Pediatr. 2009 May; 154(5)

Ambulatory children with CP had 39 % lower muscle volume and 3.3 fold higher subfascial AT volume compared to controls (both $p < 0.05$).

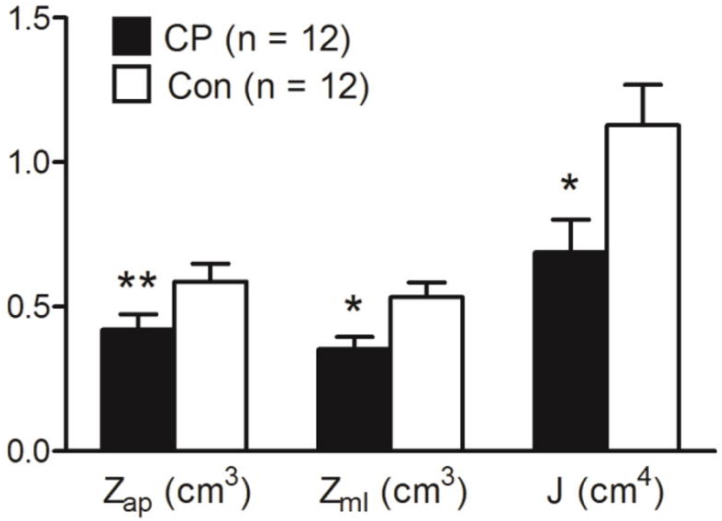
Bone. 2017 Jan; 94: 90–97.



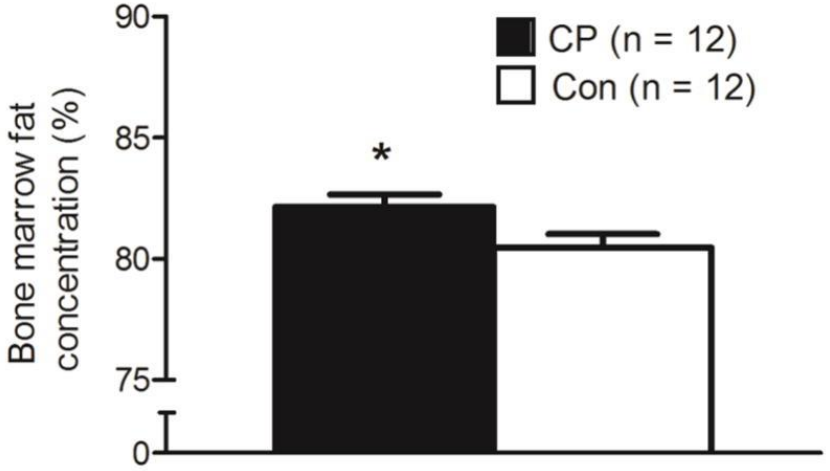
Raw T1-weighted MRI images from the midtibia demonstrate the marked deficit in bone architecture and muscle volume and the high infiltration of fat within and around the musculature in an ambulatory boy with mild CP (A) compared to a typically developing boy with the same tibia length (B). In the image of the child with CP (A), the small black arrow highlights the thin cortical shell and the large arrow highlights the fat infiltration of muscle

Physical activity (counts/d) CP 348.4 ± 197.0 / TD 628.0 ± 147.5

Ambulatory children with mild spastic CP relative to typically developing children have markedly underdeveloped bone architecture and lower estimates of bone strength



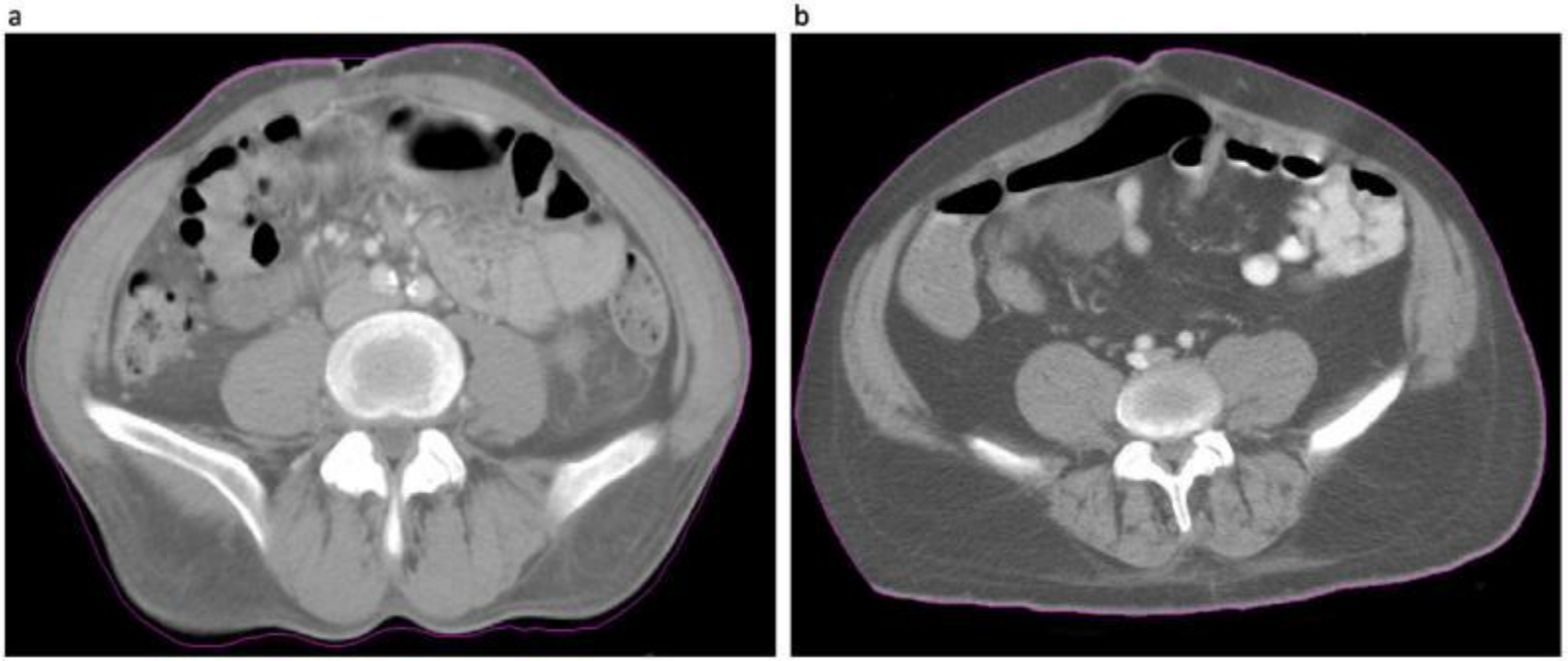
Estimates of bone strength [section modulus in the anterior-posterior (Zap) and medial-lateral (Zml) directions and polar moment of inertia (J)] in the midtibia of children with cerebral palsy (CP) and typically developing children (Con). *Group difference, $p < 0.05$. **Group difference, $p = 0.057$



Bone marrow fat concentration (%) in the midtibia of children with cerebral palsy (CP) and typically developing children (Con). *Group difference, $p < 0.05$.

Bone. 2017 Jan; 94: 90–97.

Greater adipose tissue distribution and diminished spinal musculoskeletal density in adults with cerebral palsy

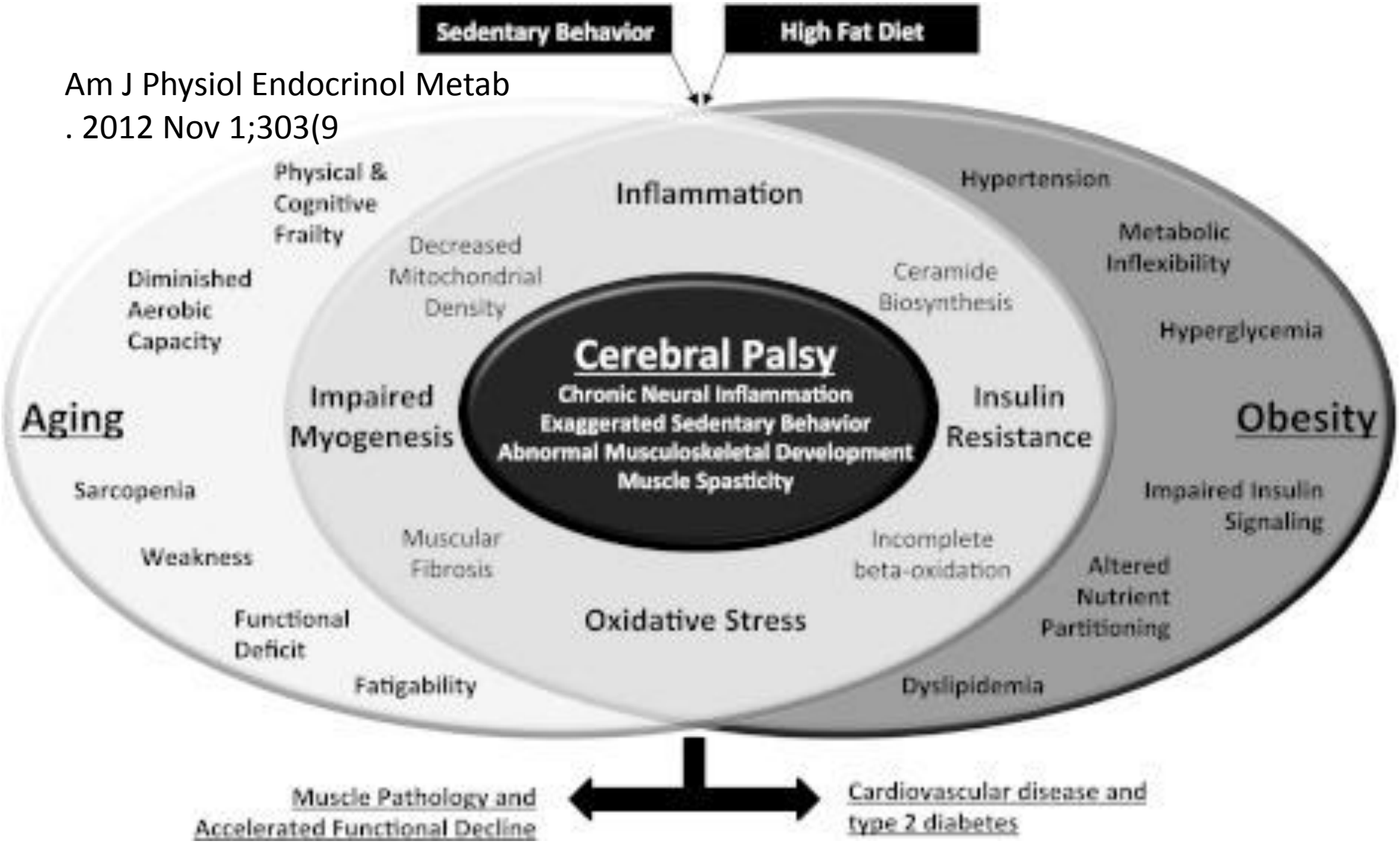


Computed tomography image at vertebral level L4, depicting trunk adiposity distribution and muscle size in: (a) a 53 year old, neuro-typical male (65 kg body mass), and (b) a 54 year old male with CP (66 kg body mass).

Arch Phys Med Rehabil. 2015 Oct; 96(10)

Secondary muscle pathology and metabolic dysregulation in adults with cerebral palsy

Am J Physiol Endocrinol Metab
. 2012 Nov 1;303(9



Multimorbidity in Middle-Aged Adults with Cerebral Palsy

Nicole Cremer, B.S., Edward A. Hurvitz, M.D., and Mark D. Peterson, Ph.D., M.S

Demographic characteristics chronic disease prevalence by gender and GMFCS category

	GMFCS I–III		GMFCS IV–V	
	Men	**Women**	**Men**	**Women**
	n=94	***n=112***	***n=77***	***n=97***
Age, years	47.62 (5.84)	49.85 (5.67)*	49.87 (5.58)†	50.37 (5.49)
Body Mass Index (BMI), kg/m^2	27.18 (5.93)†	30.66 (8.24)*†	23.84 (7.77)	27.19 (10.55)*
Obesity (BMI >30), %	18.3	44.1*†	13.2	29.5*
Smoker, %	16.0†	14.3	6.5	9.3

Am J Med. 2017 Jun; 130(6): 744.e9–744.e15.

Demographic characteristics chronic disease prevalence by gender and GMFCS

	GMFCS I–III		GMFCS IV–V	
	Men	**Women**	**Men**	**Women**
[a] Diabetes	10.8†	15.2	1.3	14.7*
Osteopenia or Osteoporosis	22.3	40.2*	55.8†	58.8†
Myocardial Infarction	3.2	3.6	3.9	4.1
Stroke	4.3	5.4†	5.2*	0
Coronary Artery Disease	1.1	4.5	0	2.1
Pre-hypertension *or* Hypertension	53.3†	51.8	36	58.1*
Other Cardiovascular Disease	12.8	15.2	18.2	16.5
Rheumatoid Arthritis	4.3	1.8	1.3	6.2*†
Osteoarthritis	30.9†	33.9	20.8	30.9*
Emphysema	2.1	1.8	5.2	2.1
Asthma	16	26.8*	19.5	21.7
Hyperlipidemia	24.5†	17.9	15.6	21.7

Am J Med. 2017 Jun; 130(6): 744.e9–744.e15.

Table 6 Incidence rate and unadjusted and adjusted HRs for NCDs using patients with complete data for smoking status, alcohol consumption, and BMI

	Complete case analysis; all patients with CP compared to matched patients without CP (n = 4,463)		Complete case analysis; patients with CP and ID compared to matched patients without CP (n = 991)		Complete case analysis; patients with CP without ID compared to matched patients without CP (n = 3,472)	
	Adjusted HR[a] (95% CI)	*p* Value	Adjusted HR[a] (95% CI)	*p* Value	Adjusted HR[a] (95% CI)	*p* Value
Cancer	1.68 (0.77–3.66)	0.194	Not estimable		1.66 (0.73–3.76)	0.224
Type 2 diabetes mellitus	1.22 (0.74–2.00)	0.434	0.51 (0.13–2.09)	0.352	1.39 (0.81–2.40)	0.237
Cardiovascular disease	1.85 (1.46–2.34)	<0.001	1.92 (0.96–3.18)	0.064	1.86 (1.44–2.39)	<0.001
Respiratory disease	2.49 (1.92–3.24)	<0.001	2.18 (1.07–4.45)	0.033	2.62 (1.97–3.47)	<0.001
Any NCD	1.91 (1.67–2.17)	<0.001	1.71 (1.08–2.71)	0.022	1.97 (1.72–2.24)	<0.001
Heart failure	3.38 (1.44–7.91)	0.005	—		—	
Hypertensive disease	1.94 (1.50–2.52)	<0.001	—		—	
Ischemic heart disease	2.18 (1.22–3.89)	0.008	—		—	
Cerebrovascular disease	4.44 (1.77–11.17)	0.002	—		—	
Other heart diseases	1.32 (0.70–2.51)	0.391	—		—	
COPD	1.95 (1.17–3.25)	0.010	—		—	
Asthma	2.31 (1.74–3.08)	<0.001	—		—	

Abbreviations: BMI = body mass index; CI = confidence interval; COPD = chronic obstructive pulmonary disease; CP = cerebral palsy; HR = hazard ratio; ID = intellectual disability; NCD = noncommunicable disease.
[a] Adjusted for smoking status, alcohol consumption, BMI, and mean yearly general practitioner consultations.

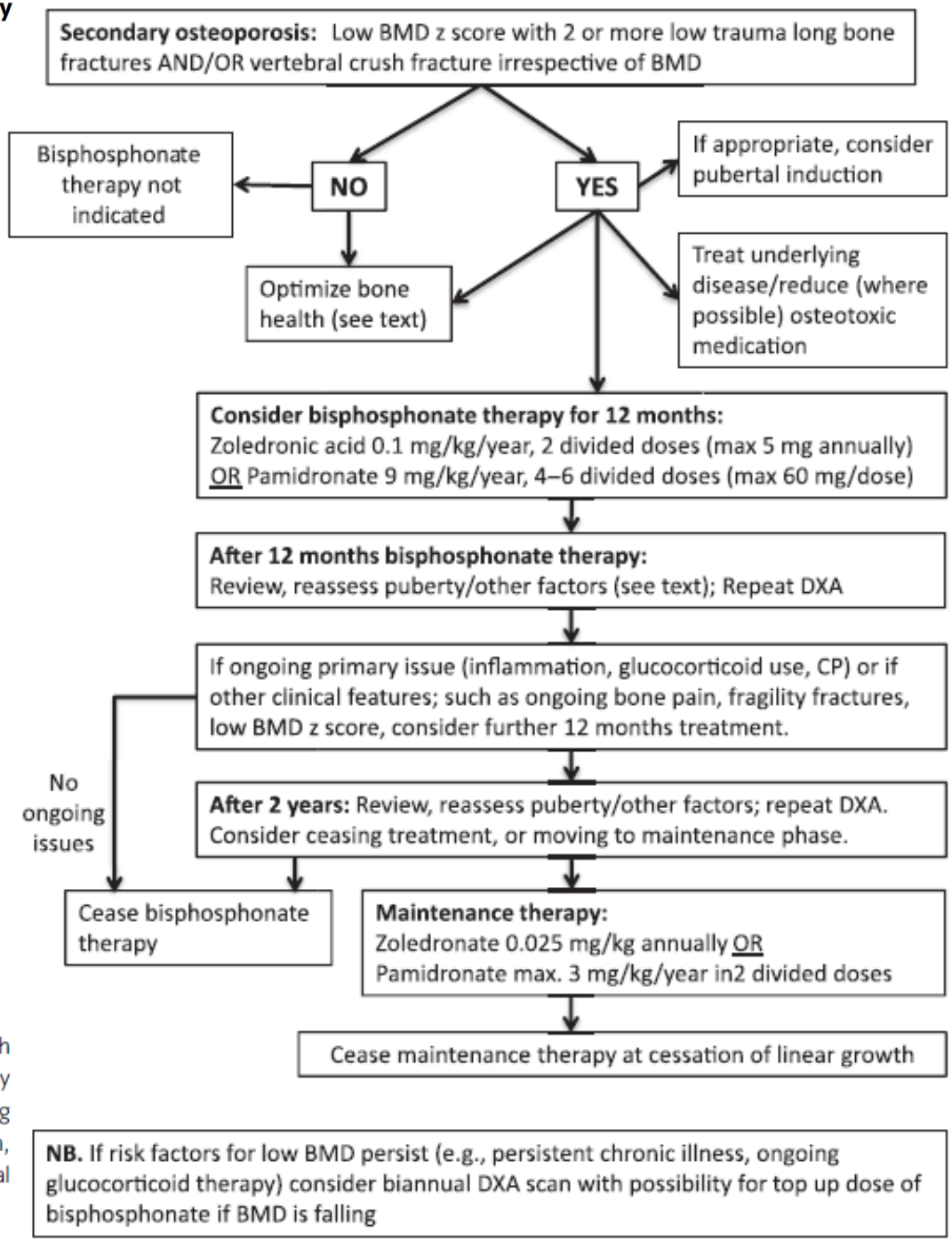


Fig. 2 Flow chart of the use of bisphosphonates in a young person with secondary osteoporosis. Note: Optimise bone health – Optimise dietary calcium intake, ensure vitamin D is sufficient, maximise weight-bearing exercise. Other factors assessed at 12 months: Fracture rate, bone pain, mobility and other medications. BMD, bone mineral density; CP, cerebral palsy; DXA, dual energy X-ray absorptiometry.

Definition of Sarcopenia(EWGSOP)

- ↓ muscle mass, strength & performance

- height-adjusted skeletal muscle mass (ASM/height^2)
  7.0 kg/m^2 for men
  5.4 kg/m^2 for women
- hand-grip strength
  < 26 kg for men
  < 18 kg for women
- SPPB(short physical performance battery) was <9 (balance, gait speed, sit to stand)

Sarcopenia among Adults with CP in South Korea

	N	ASM/Height2	Sarcopenia(%)
Men			
<40	20	6.50 ± 1.12	65
40~49	17	6.97 ± 1.13	53.8
≥50	9	6.08 ± 1.50	77.8
Women			
<40	15	5.65 ± 0.681	20
40~49	15	5.82 ± 0.843	15.4
≥50	4	4.31 ± 0.785	100

Inpyo Jeon MD Moon Suk Bang MD, PhD Jae Young Lim MD, PhD Hyung-Ik Shin MD, PhD Ja-Ho Leigh MD KeeWon Kim MD, PhD Bum Sun Kwon MD, PhD Soong-Nang Jang PhD Se Hee Jung MD, PhD PM R. 2019 Dec;11(12):1296-1301

Recumbent Cross-Training Is a Feasible and Safe Mode of Physical Activity for Significantly Motor-Impaired 11 Adults With Cerebral Palsy

Arch Phys Med Rehabil. 2013 Feb; 94(2): 401–407.

Prevalence of Mental Health Disorders Among Adults With Cerebral Palsy A Cross-sectional Analysis

Table 2. Age-Standardized Prevalence of Mental Health Disorder Categories for Study Participants

Category	Women			Men		
	CP Alone, % (95% CI)	CP and ND Disorder, % (95% CI)	Without CP, %	CP Alone, % (95% CI)	CP and ND Disorder, % (95% CI)	Without CP, %
Schizophrenia, schizotypal disorder, delusional, and other nonmood psychotic disorders	3.2 (2.5 to 3.9)	7.3 (5.8 to 8.8)	0.6	2.8 (2.2 to 3.4)	6.5 (5.1 to 7.9)	0.7
Mood affective disorders	28.6 (26.8 to 30.4)	28.8 (26.1 to 31.5)	14.3	19.5 (18.0 to 21.0)	23.3 (20.9 to 25.7)	8.1
Anxiety, dissociative, stress-related, somatoform, and other nonpsychotic mental disorders	28.6 (26.8 to 30.4)	29.6 (26.9 to 32.3)	18.0	19.5 (18.0 to 21.0)	21.7 (19.4 to 24.0)	11.1
Behavioral syndromes associated with physiologic disturbances and physical factors	2.0 (1.5 to 2.5)	1.7 (0.9 to 2.5)	1.8	2.1 (1.5 to 2.7)	2.1 (1.3 to 2.9)	1.7
Disorders of adult personality and behavior	1.2 (0.8 to 1.6)	4.4 (3.2 to 5.6)	0.4	1.2 (0.8 to 1.6)	4.1 (3.0 to 5.2)	0.3
Alcohol- and/or opioid-related disorders	2.8 (2.2 to 3.4)	2.2 (1.3 to 3.1)	1.8	4.7 (3.9 to 5.5)	2.4 (1.5 to 3.3)	3.0

CP = cerebral palsy; ND = neurodevelopmental.

Ann Intern Med
. 2019 Sep 3;171(5):328-333

Adult cerebral palsy clinic

- Transition of care
- Family centered

- Primary medical provider
- Specialist at tertiary hospital

- Multi-displinary Team

Transition to adulthood

- Accelerated aging
- Premature fragility
- Normal weight obesity
- Exaggerated sedentariness

Rehabilitation Goal

- The prevention of decline and maintenance of functional mobility is an important goal in intervention for individuals with CP, as well as for their parents and healthcare professionals.

- In addition to ongoing needs traced to childhood, regular reviews of cardiovascular health, cervical cytology and mammography in women, access to dental care and screening is important in adults diagnosed with CP

Spasticity, spasm, dystonia

Dysphagia, Nutrition, GE reflux

Voiding problem

Psychologic problem, dementia

Respiratory problem, sleep apnea

Vision & hearing

Gait, ADL function

Sarcopenia, osteoporosis

Pain, Fatigue

Metabolic, degenerative disease

Cancer, poor medical surveillance

Family problem