

ORIGINAL RESEARCH

Bone Density in Premenopausal Women and Men Under 50 Years of Age With Cerebral Palsy



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Abstract

Objective: To determine bone mineral density (BMD) z scores in adults with cerebral palsy (CP), an understudied population.

Design: Cross-sectional.

Setting: Medical facility.

Participants: Adults ($N=48$; mean age, 34.3 ± 5.8 y; range, 25–46y) with CP.

Interventions: Not applicable.

Main Outcome Measures: BMD z scores at the lumbar spine and hip using dual-energy x-ray absorptiometry, Gross Motor Function Classification System (GMFCS), body mass index (BMI), and ambulatory status.

Results: Mean BMD z scores were -1.40 for the lumbar spine, -1.36 for the total hip, and -1.02 for the femoral neck. The z scores were significantly lower for the nonambulatory group at all 3 sites ($P<.05$). Significant differences were found among GMFCS levels for the lumbar spine and total hip z scores ($P<.05$). For the lumbar spine, the mean z scores for level V (the lowest mobility level) were significantly lower than the mean for levels I/II ($P=.001$), III ($P=.002$), and IV ($P=.013$). For the total hip, the mean z scores for level V were significantly lower than the mean for levels I/II ($P=.045$). A significant positive relationship between the z scores and age was found for the lumbar spine (Spearman $\rho=.40$, $P=.005$). Significant positive relationships between BMI and z scores were found for all sites ($P<.05$).

Conclusions: This study contributes to the sparse literature about bone health in adults with CP. In contrast with pediatric data, z scores did not decrease as a function of age in this adult cohort. This information is important for clinicians considering treatment options for this population. Archives of Physical Medicine and Rehabilitation 2015;96:1304-9

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The high prevalence of low bone mineral density (BMD) in children with cerebral palsy (CP) is well established.¹⁻³ Children with CP exhibit reduced BMD relative to nondisabled peers, and the difference increases with age.⁴ Low BMD in 139 children with spastic CP was most highly correlated with level of ambulation followed by nutritional status, including body mass index (BMI).¹ Pattern of involvement, duration of immobilization, and calcium intake were related factors. Risk of pathologic fracture can be

related to severity of CP, previous fractures, insufficient growth, poor nutrition, anticonvulsants, low vitamin D, and skeletal maturation.^{1,5}

There is less information about BMD in adults with CP. Adults with CP are at risk for typical disabilities associated with aging, including osteoporosis, but these may occur at an earlier age. Aging with preexisting musculoskeletal abnormalities (eg, osteopenia, scoliosis, joint contractures, abnormal biomechanics) may cause pain, chronic fatigue, and premature functional decline.^{6,7} These secondary effects of CP further reduce physical activity, thereby decreasing impact loading critical for bone health.⁶

There are few studies of BMD in adults with CP. King et al⁸ used lumbar spine dual-energy x-ray absorptiometry (DXA) to assess bone health in 48 nonambulatory children and adults (age range, 5–48y) with spastic CP. The average z score was

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$-2.37 \pm .21$, and 58% had z scores below the expected range of ≥ -2.0 . The average z scores for the 19 adult participants ($-2.45 \pm .40$) were similar to the group average. Anticonvulsants, associated with lower BMD,⁹ were used by 60% of patients. Yoon et al¹⁰ evaluated 38 adults with CP in their 20s to 50s, but they reported DXA T scores, limiting comparisons of results with the literature. T scores compare the BMD of an individual to peak bone mass and are not recommended for evaluating men <50 years of age or premenopausal women. Instead, z scores, which compare BMD to individuals of the same age, sex, and race, are recommended.^{11,12} The authors reported an average T score of $-1.08 \pm .22$ for the lumbar spine and $-1.5 \pm .20$ for the hip and a significant positive correlation between T scores and BMI. Significant positive correlations between hip T scores and both function and mobility levels were found.

A study of 123 adults with CP (age range, 21–46y) residing in Japanese institutions found poor bone health based on metacarpal bone radiographs.¹³ Reduced BMD was associated with anticonvulsant medication use in both sexes, decreased ambulation level in women, and a higher alkaline phosphatase level in men. Relationships between BMD and age or BMI were not found. This method assesses primarily cortical, not trabecular, bone and is not a standard way of assessing BMD.

Previous studies have not assessed z scores in a cohort that includes both ambulatory and nonambulatory adults with CP. The purpose of this study was to quantify BMD in premenopausal women and men <50 years of age with CP using DXA scans of the lumbar spine, total hip, and femoral neck. We hypothesized that individuals with lower mobility levels would have significantly lower BMD and that z scores would decrease with age because of the premature decline in function reported for adults with CP.

Methods

Participants

Forty-eight adults with CP were recruited. Inclusion criteria were: diagnosis of CP and age between 25 and 45 years for women and 25 and 50 years for men. Exclusion criteria were: previous treatment for low BMD, post- or perimenopausal women, history of oophorectomy, metal implants in the spine or hip, and chronic steroid therapy. The Institutional Review Board of the UCLA Human Research Protection Program approved the study protocol and consent procedures.

Study design

This is a prospective cross-sectional study of adults with CP.

Procedures

Patients were recruited via flyers placed in a CP lifespan outpatient clinic and distributed to disability organizations. Informed

List of abbreviations:

BMD	bone mineral density
BMI	body mass index
CP	cerebral palsy
DXA	dual-energy x-ray absorptiometry
GMFCS	Gross Motor Function Classification System

consent was obtained from participants and, when applicable, legal guardians.

Patient assessment

Ambulatory and mobility levels were assigned by a physical therapist. Participants were categorized as ambulatory (able to walk any distance with or without the use of assistive devices) versus non-ambulatory to determine weight-bearing exposure. Mobility was assessed using the Gross Motor Function Classification System–Expanded and Revised (GMFCS).¹⁴ GMFCS levels for this study were assigned as follows: levels I and II (independent walking without assistive devices); level III (independent walking with a handheld device); level IV (self-mobility with limitations; primarily use wheeled mobility); and level V (dependent mobility; transported in a manual wheelchair with adapted seating or use power mobility with extensive adaptations). Specific CP diagnosis was determined from the medical record or by self-report. Risk factors for low BMD, including seizure disorders, family history of osteoporosis, cigarette use, and heavy alcohol use, were determined by interview.

Bone mineral density

A single DXA scanner^a was used for all BMD assessments. A research team member ensured that the participant was positioned comfortably with the hip in neutral rotation. In the presence of hip or knee flexion contractures, a pillow was placed under the distal thigh. The coefficient of variation was 1% for the lumbar spine and 1.5% for the hip. Lumbar spine, total hip, and femoral neck BMD z scores were calculated using standard normative data for sex, age, and race. A subregion analysis of the femoral neck z scores, used in the calculation of the total hip z score, was performed because it is a common fracture site in adults.¹⁵ Scans with evidence of osteophytes were removed from further analyses. Participants with z scores of ≤ -2 were referred to their primary physician or the osteoporosis center at our institution for further consultation.

Statistics

Statistics were calculated using JMP Pro11 software.^b Quantile plots were examined for normality, and significant deviations were not found. Independent Student t tests were used to examine differences in mean z scores by ambulatory status. A 1-way analysis of variance with post hoc Tukey test was used to evaluate differences in z scores by GMFCS level. The relationships between z scores and continuous predictors (age, BMI) were assessed using Spearman correlation statistics. Further analyses were performed to determine the presence of outliers or confounding factors as indicated. Significance was set at $P < .05$.

Results

Participant characteristics ($N = 48$; age range, 25–46y) are shown in table 1. Height could not be measured accurately in 2 participants; therefore, height and BMI are reported for 46 participants. The most common CP diagnosis was spastic diplegia. Fewer participants functioned at GMFCS levels III and V compared with the other levels. More patients were ambulatory than nonambulatory.

The mean z scores are shown in table 2. Data from 2 lumbar spine DXAs were excluded because of scoliosis ($n = 1$) and a large osteophyte ($n = 1$), reducing the sample size to 46. The mean z scores for all participants were lowest for the lumbar spine and

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