

# Reference curves for bone mineral density in Korean adolescents and young adults aged 10 to 25 years: The Korean NHANES, 2009~2011

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## Introduction

Currently, the most commonly used quantitative radiologic method for assessing bone mass is dual-energy x-ray absorptiometry (DXA). Lumbar spine (LS), total body (TB), and total body less head (TBLH) scans are recommended for preferred for clinical assessment of bone health in children. However, normative data for bone mineral density (BMD) in Asian adolescents and youth are scarce.

## Objectives

We aimed to provide normative values and reference curves for BMD in Korean adolescents and youth.

## Subjects and Methods

Using the data from Korean National Health and Nutrition Examination Survey (KNHANES) in 2008~2011, a total of 3,352 subjects (1,635 males and 1,717 females aged 10-25 years), were included for this study. BMD were measured using DXA at LS, TB, and TBLH. Age related reference curves for BMD were generated using the LMS statistical procedure.

## Results

The BMD increased with age in both genders, and reached a plateau at ages 16-17 in males and at age 15 in females. Peak BMD velocities occurred at ages 13-14 in males; at ages 11-12 in females. Peak bone mass (PBM) of all study regions was achieved by the age of 21 and 19 in male and females, respectively. BMD in LS, TB, and TBLH was maintained until the age of 25.

Table 1. Lumbar spine BMD : LMS parameters and BMD values of -2SD by sex

Age yr (n)	Male				Age yr (n)	Female			
	L	M	S	-2SD		L	M	S	-2SD
10 (119)	0.068	0.577	0.133	0.441	10 (106)	0.560	0.643	0.150	0.463
11 (123)	0.226	0.630	0.135	0.477	11 (113)	0.588	0.710	0.144	0.518
12 (131)	0.380	0.687	0.136	0.515	12 (95)	0.616	0.774	0.139	0.571
13 (110)	0.516	0.749	0.137	0.557	13 (120)	0.640	0.828	0.134	0.617
14 (139)	0.624	0.810	0.137	0.600	14 (100)	0.656	0.869	0.129	0.655
15 (101)	0.701	0.861	0.136	0.638	15 (84)	0.661	0.899	0.125	0.684
16 (90)	0.743	0.901	0.133	0.669	16 (97)	0.659	0.920	0.121	0.706
17 (100)	0.754	0.929	0.131	0.695	17 (90)	0.648	0.934	0.119	0.722
18 (83)	0.746	0.951	0.128	0.716	18 (64)	0.625	0.942	0.116	0.733
19 (92)	0.731	0.968	0.125	0.735	19 (116)	0.587	0.948	0.115	0.741
20 (45)	0.719	0.984	0.122	0.752	20 (87)	0.531	0.952	0.113	0.747
21 (55)	0.712	0.997	0.120	0.767	21(106)	0.451	0.955	0.113	0.753
22 (102)	0.712	1.005	0.117	0.778	22 (102)	0.352	0.957	0.112	0.758
23 (101)	0.721	1.007	0.115	0.784	23 (122)	0.241	0.957	0.111	0.762
24 (78)	0.735	1.006	0.113	0.786	24 (134)	0.123	0.957	0.110	0.766
25 (105)	0.754	1.003	0.111	0.787	25 (111)	0.001	0.957	0.109	0.770

Table 2. Total body BMD : LMS parameters and BMD values of -2SD by sex

Age yr (n)	Male				Age yr (n)	Female			
	L	M	S	-2SD		L	M	S	-2SD
10 (118)	0.035	0.852	0.090	0.712	10 (108)	0.770	0.846	0.104	0.674
11 (127)	0.057	0.892	0.093	0.740	11 (111)	0.754	0.894	0.102	0.716
12 (133)	0.084	0.933	0.096	0.769	12 (95)	0.733	0.940	0.101	0.756
13 (109)	0.119	0.976	0.098	0.801	13 (123)	0.708	0.981	0.099	0.792
14 (143)	0.168	1.020	0.100	0.833	14 (105)	0.682	1.013	0.098	0.821
15 (105)	0.240	1.058	0.100	0.861	15 (89)	0.657	1.038	0.097	0.844
16 (93)	0.314	1.091	0.100	0.886	16 (97)	0.633	1.055	0.095	0.862
17 (105)	0.370	1.118	0.100	0.909	17 (99)	0.603	1.068	0.094	0.875
18 (87)	0.403	1.142	0.098	0.930	18 (66)	0.547	1.077	0.092	0.887
19 (92)	0.419	1.163	0.097	0.951	19 (117)	0.459	1.085	0.091	0.898
20 (46)	0.424	1.182	0.095	0.970	20 (93)	0.338	1.092	0.089	0.908
21 (51)	0.422	1.197	0.093	0.987	21(104)	0.192	1.098	0.088	0.917
22 (97)	0.416	1.206	0.091	1.000	22 (103)	0.027	1.103	0.087	0.926
23 (97)	0.410	1.211	0.088	1.008	23 (124)	-0.150	1.108	0.086	0.935
24 (80)	0.409	1.209	0.086	1.011	24 (139)	-0.336	1.111	0.084	0.944
25 (108)	0.414	1.205	0.084	1.012	25 (117)	-0.527	1.114	0.082	0.951

Table 3. Total body less head BMD : LMS parameters and BMD values of -2SD by sex

Age yr (n)	Male				Age yr (n)	Female			
	L	M	S	-2SD		L	M	S	-2SD
10 (118)	0.157	0.705	0.098	0.578	10 (108)	1.035	0.716	0.109	0.560
11 (127)	0.227	0.757	0.100	0.617	11 (111)	0.899	0.758	0.106	0.600
12 (133)	0.307	0.808	0.101	0.655	12 (95)	0.766	0.797	0.102	0.638
13 (109)	0.397	0.858	0.103	0.693	13 (123)	0.640	0.828	0.099	0.670
14 (143)	0.495	0.904	0.103	0.727	14 (105)	0.530	0.850	0.096	0.695
15 (105)	0.608	0.941	0.104	0.754	15 (89)	0.434	0.866	0.093	0.713
16 (93)	0.720	0.968	0.103	0.775	16 (97)	0.346	0.877	0.091	0.727
17 (105)	0.809	0.990	0.102	0.792	17 (99)	0.253	0.884	0.089	0.737
18 (87)	0.868	1.007	0.101	0.807	18 (66)	0.135	0.889	0.087	0.746
19 (92)	0.902	1.023	0.099	0.822	19 (117)	-0.018	0.895	0.085	0.755
20 (46)	0.922	1.038	0.098	0.837	20 (93)	-0.203	0.899	0.084	0.763
21 (51)	0.931	1.050	0.096	0.850	21(104)	-0.416	0.903	0.083	0.769
22 (97)	0.934	1.058	0.094	0.861	22 (103)	-0.650	0.905	0.082	0.775
23 (97)	0.937	1.062	0.092	0.868	23 (124)	-0.901	0.906	0.081	0.779
24 (80)	0.943	1.062	0.090	0.871	24 (139)	-1.166	0.907	0.080	0.783
25 (108)	0.952	1.060	0.089	0.873	25 (117)	-1.441	0.908	0.080	0.787

Fig.1. Reference curves for lumbar spine BMD

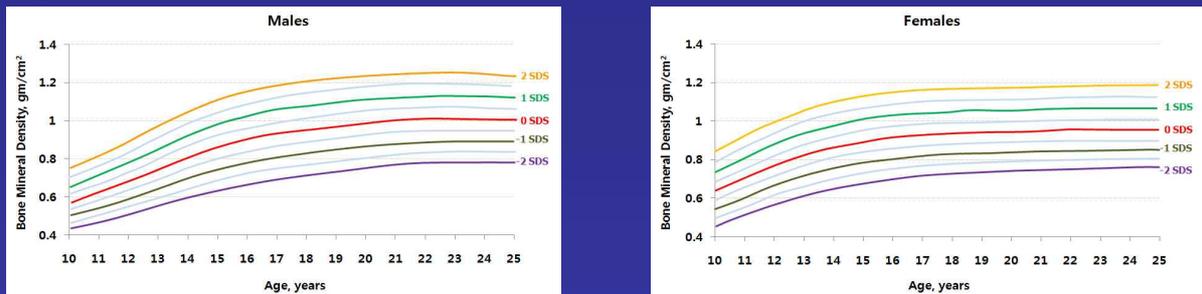


Fig.2. Reference curves for total body BMD

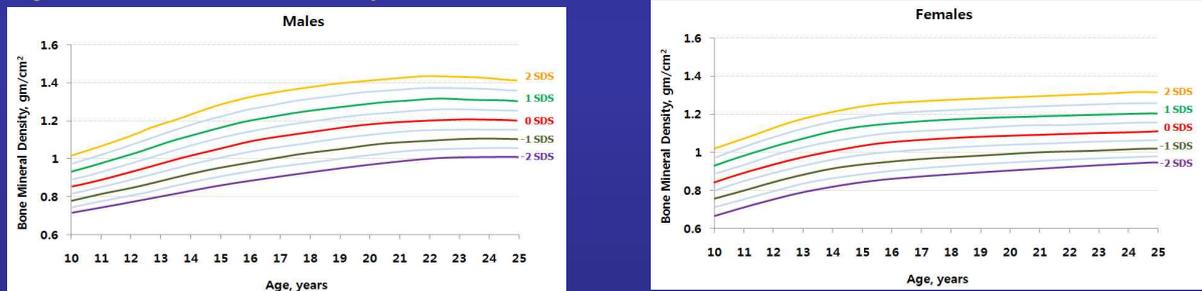
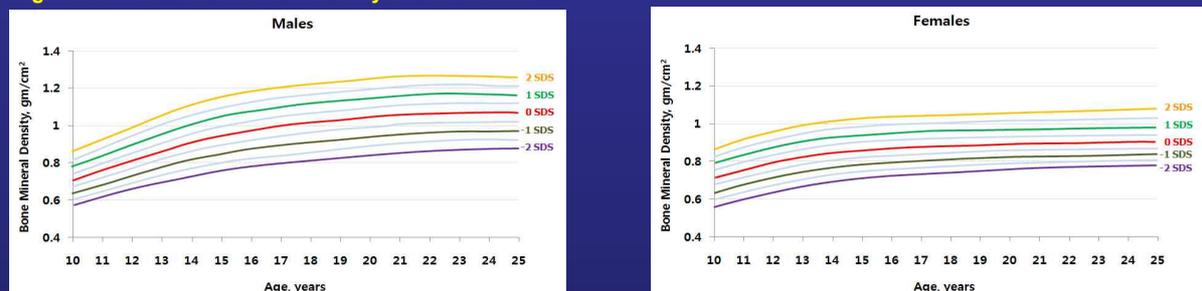


Fig.3. Reference curves for total body less head BMD



## Conclusions

These reference curves for BMD can be used to assess and monitor the bone health in Korean adolescents and youth.