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SPECIAL REPORT

Diagnostic criteria for primary osteoporosis: year 2012 revision

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Abstract In 1995, the Japanese Society for Bone and Mineral Metabolism (now the Japanese Society for Bone and Mineral Research) established the Osteoporosis Diagnostic Criteria Review Committee. Following discussion held at the 13th scientific meeting of the Society in 1996, the Committee, with the consensus of its members, proposed diagnostic criteria for primary osteoporosis. The Committee revised those criteria in 1998 and again in 2000. The Japanese Society for Bone and Mineral Research and Japan Osteoporosis Society Joint Review Committee for the Revision of the Diagnostic Criteria for Primary Osteoporosis aimed at obtaining international consistency and made a revised edition based on the new findings in 2012.

Keywords Diagnostic criteria · Primary osteoporosis · BMD · Fragility fracture

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Introduction

The year 2000 diagnostic criteria for primary osteoporosis of 2000 are used now in Japan. Some issues have been pointed out since those criteria were proposed. The main issues were discrepancy of the Japanese diagnostic criteria and the diagnostic criteria by WHO. Furthermore, new findings about the relative risk of a new fracture occurrence by prevalent fractures and about measurement of bone mineral density have been obtained. Therefore, the Japanese Society for Bone and Mineral Research and Japan Osteoporosis Society Joint Review Committee for the Revision of the Diagnostic Criteria for Primary Osteoporosis aimed at obtaining international consistency and made a revised edition based on the new findings in 2012.

Issues with the year 2000 diagnostic criteria for primary osteoporosis

Table 1 [1] shows the year 2000 diagnostic criteria for primary osteoporosis. The main issues that have been identified since those criteria were proposed are listed below.

1. Differences between the Japanese criteria and the WHO criteria
   - Should standard deviation (SD) (WHO), percentage (%) (Japan), or both be used?
   - Should 1 SD (WHO) or 1.5 SD (Japan) below the Young Adult Mean (YAM) be used to define low bone mass (osteopenia)?
   - How should the presence of a fragility fracture be classified by fracture location (Japan)?
   - Should the WHO definition for severe osteoporosis be used in Japan?
2. Issues with the cutoff values and measurement sites for bone mineral density (BMD)
   - Should both L1–L4 (International) and L2–L4 (Japan) be presented?
   - Is the mean density and SD for each vertebra necessary?
   - Is the 20–44 year old age range appropriate for calculating the YAM for the proximal femur?
   - Is percentage (%), instead of SD, acceptable for the widespread measurement of the radius and metacarpus in Japan?

Table 1 Diagnostic criteria for primary osteoporosis (year 2000 revision). Primary osteoporosis is diagnosed when no disease causing low bone mineral density other than osteoporosis and no secondary osteoporosis are observed, and the results of bone assessment meet the following requirements

I. With fragility fracture[a]

II. Without fragility fracture

	BMD[b]	Radiographic osteopenia of the spine[c]
Normal	80 % of YAM or higher	Absent
Low bone mass	70–80 % of YAM	Possible
Osteoporosis	Less than 70 % of YAM	Present

Radiographic osteopenia of the spine	Existing standards for evaluating bone atrophy
Absent	Absence of atrophy
Possible	Level I atrophy
Present	Level II atrophy and above

YAM Young Adult Mean (age 20–44 years)

[a] Fragility fracture is a nontraumatic bone fracture that is caused by slight external force to a bone with low BMD (BMD less than 80 % of YAM). Sites of fracture include the spine, femoral neck, and the distal end of the radius

[b] Bone mineral density usually refers to lumbar BMD. However, when this measurement is inappropriate for reasons such as spinal deformity, the femoral neck BMD should be used. When measurements at those sites are difficult, BMD of the radius, second metacarpal bone, or calcaneus will be used

[c] In the evaluation of bone loss in spinal X-ray images, existing standards for evaluating bone atrophy shall be referenced

- Should only the proximal femur be used as the diagnostic criteria for men? Or should the lumbar spine also be used?
- Should quantitative ultrasound (QUS) be adopted?

New diagnostic criteria for primary osteoporosis (year 2012 revision)

After investigating the aforementioned issues with the year 2000 diagnostic criteria, the Committee developed new diagnostic criteria for the 2012 revision that are listed in Table 2.

For the diagnosis of primary osteoporosis, differential diagnosis is essential, and upon performing exclusion diagnosis, the new diagnostic criteria listed in Tables 2 and 3 shall be used to diagnose primary osteoporosis. As for secondary osteoporosis, outside of the year 2004 guidelines for the management and treatment of glucocorticoid-induced osteoporosis [2], no diagnostic criteria or any criteria for the initiation of medical treatment have been established, which has caused the diagnostic criteria for primary osteoporosis to be used instead. However, it is necessary to keep in mind that the diagnostic criteria outlined within this report are not intended for secondary osteoporosis.

The major differences between the new criteria and the criteria from the year 2000 revision, along with the reasons for these changes are listed below.

1. Classification based upon the variety of prevalent fracture was added.

In the presence of a prevalent fracture, the relative risk of a new fracture occurrence is approximately 2 times greater than those without pre-existing fracture, regardless of the variety of the pre-existing fracture [3, 4]. However, in the cases of pre-existing vertebral fracture, the relative risk of a new vertebral fracture occurrence is, after correcting for BMD, approximately 3–4 times greater than those without pre-existing fracture, while the relative risk of a new fracture occurrence in the proximal femur is 3–5 times greater [5]. Also, in the cases of pre-existing fracture in the proximal femur, the relative risk of a new fracture occurrence is 2.5 [6] to 6.8 [7] times greater than those without pre-existing fracture. Additionally, a prevalent vertebral fracture in conjunction with low bone mass raises the relative risk of a new fracture occurrence to 1.6 times that for osteoporosis with no prevalent vertebral fracture [8]. Considering all of this, it has been decided that, regardless of BMD, cases for which either pre-existing vertebral or proximal femoral fractures are present shall be classified as osteoporosis. Cases in which other fractures are present shall be treated as they have been up until now, with cases for which the BMD is less than 80 % of the YAM classified as osteoporosis. Other Fractures shall refer to fractures found in the six major non-vertebral regions, excluding the proximal femur, as defined by the WHO.

2. Regions for BMD measurement shall, as a general rule, be the lumbar spine and/or the proximal femur.

Table 2 Diagnostic criteria for primary osteoporosis (year 2012 revision). Primary osteoporosis is diagnosed when no disease causing low bone mineral density other than osteoporosis and no secondary osteoporosis are observed, and the results of bone assessment meet the following requirements

I. Presence of a fragility fracture[a]

1. Presence of a fracture in either the lumbar spine[b] or the proximal femur
2. Presence of an other fragility fracture[c] and a BMD[d] below 80 % of YAM

II. Absence of fragility fracture

BMD[d] is equal to or below either 70 % or −2.5 SD of YAM

Low bone mass (osteopenia): BMD equal to or below −1.0 SD, but above −2.5 SD of YAM shall be classified as low bone mass

YAM Young Adult Mean (lumbar spine: 20–44 year age range, proximal femur: 20–29 year age range)

[a] A non-traumatic fracture resulting from minor external force. Minor external force refers to any external force that is equal to or below that for falling from a standing position

[b] It is important to keep in mind that 2 out of 3 morphological vertebral fractures are asymptomatic and it is recommended that spinal X-ray images should be examined also for differential diagnosis

[c] Other fragility fracture: a non-traumatic fracture resulting from minor external force that occurs in the rib, pelvis (including the pubis, ischium, and sacrum), proximal humerus, distal radius, and tibia

[d] In principle, BMD shall refer to the BMD of either the lumbar spine or proximal femur. In cases in which multiple measurements are made, the lower of the percentage (%) and SD values shall be adopted. In the lumbar spine, BMD from either L1–L4 or L2–L4 shall be the standard values. Also, for elderly patients where it is difficult to measure lumbar spine BMD due to issues such as spinal deformation, the BMD from the proximal femur shall be used. BMD measurements from either the femoral neck or the total hip (total proximal femur) can be used for proximal femur BMD. Should all of the measurements become difficult to perform, BMD measurements can also be made in the radius and second metacarpal bone, but only the percentage (%) value shall be used. The BMD cut-off values for the Japanese population are shown in Table 3

Internationally, measurements from these areas are the standard. In cases in which multiple measurements are made, the lower of the percentage (%) and SD values shall be adopted. Additionally, as will be described later, both SD and percentage (%) values shall be listed together. For the radius and second metacarpal bone, there exists a large difference between the SD and percentage (%) values. Therefore, regions for BMD measurement shall, as a general rule, be the lumbar spine and/or the proximal femur. However, should measurement at these sites become difficult, it is acceptable to perform measurements at the radius and the second metacarpal bone.

3. The 20–29 year old age range shall form the basis of the YAM for BMD in the proximal femur.

The 20–29 year old age range was selected as the basis for the YAM for the purpose of complying with international standards and for the reason that, relative to the lumbar vertebrae, the rate of BMD loss in the proximal femur is higher in individuals that are 30 years of age or older [9]. The cutoff values that are used in the new standards (listed in Appendix) are closer to the intersection of the specificity and sensitivity curves that were examined during the development of the 1996 diagnostic criteria and are thought to be appropriate from the standpoint of assessing fracture risk.

4. SD shall be listed alongside the percentage (%) value for BMD

Using both the YAM percentage and SD criteria, there was an overlap between the BMD cutoff values from 1996 and 2006 for both men and women, with no substantial difference between them. In Table 4, the BMD cutoff values for both the lumbar spine and the proximal femur are shown for the existing (1996) and 2006 data, which was calculated using both the 70 % YAM and −2.5 SD criteria. For the lumbar spine, using the 70 % YAM criteria resulted in a slightly smaller difference between the 1996 and 2006

Table 3 BMD cut-off values for the Japanese population (g/cm^2)

Measurement region	Measurement device	BMD (YAM ± SD)	BMD cut-off values corresponding to 80 % of YAM	Osteoporosis cut-off values[b]
Women				
Lumbar spine (L1–L4)	QDR[a]	0.989 ± 0.112	0.791	0.709
	DPX[a]	1.152 ± 0.139	0.922	0.805
	DCS-900[a]	1.020 ± 0.116	0.816	0.730
Lumbar spine (L2–L4)	QDR	1.011 ± 0.119	0.809	0.708
	DPX	1.192 ± 0.146	0.954	0.834
	DCS-900[a]	1.066 ± 0.126	0.853	0.751
	XR	1.040 ± 0.136	0.832	0.728
	1X	1.084 ± 0.129	0.867	0.758
Femoral neck	QDR[a]	0.790 ± 0.090	0.632	0.565
	DPX[a]	0.939 ± 0.114	0.751	0.654
	DCS-900[a]	0.961 ± 0.114	0.769	0.676
Total hip	QDR[a]	0.875 ± 0.100	0.700	0.625
	DPX[a]	0.961 ± 0.130	0.769	0.636
	DCS-900[a]	0.960 ± 0.114	0.768	0.675
Radius	DCS-600	0.646 ± 0.052	0.517	0.452
	XCT-960 (mg/cm^3)	405.36 ± 61.68	324.29	283.75
	pDXA	0.753 ± 0.066	0.602	0.527
	DTX-200	0.476 ± 0.054	0.381	0.333
Second metacarpal bone	CXD (mmA1)	2.741 ± 0.232	2.193	1.919
	DIP (mmA1)	2.864 ± 0.247	2.291	2.005
Men				
Radius	DCS-600	0.772 ± 0.070	0.618	0.540
	DTX-200	0.571 ± 0.065	0.457	0.400
Second metacarpal bone	DIP (mmA1)	2.984 ± 0.294	2.387	2.089

[a] Data from the 2006 revision was added and altered to the 1996 data

[b] The cut-off values in the absence of a fragility fracture (either 70 % or −2.5 SD of YAM) are shown

Table 4 Comparison of cut-off values

Sex	Measurement region	Measurement device	70 % (1996)	70 % of YAM(2006)		−2.5 SD (2006)	
				BMD (g/cm^2)	Corresponding SD value	BMD (g/cm^2)	Corresponding % value
Lumbar spine BMD values (20–44 years of age)							
Women	L2–L4	QDR	0.708	0.707	−2.5	0.713	70.5
		DPX	0.834	0.826	−2.5	0.823	69.7
Men	L2–L4	QDR	0.711	0.717	−2.3	0.697	68.0
		DPX		0.797	−2.1	0.733	64.4
Proximal Femur BMD values[a]							
Women	Neck	QDR	0.551	0.553	−2.6	0.566	71.5
		DPX	0.640	0.657	−2.5	0.654	69.6
	Total hip	QDR	0.604	0.613	−2.6	0.625	71.4
		DPX		0.673	−2.2	0.636	66.2
Men	Neck	QDR	0.604	0.580	−2.7	0.598	72.2
		DPX		0.706	−2.5	0.701	69.5
	Total hip	QDR	0.672	0.669	−2.2	0.628	65.7
		DPX		0.732	−2.3	0.709	67.7

[a] The 1996 YAM standards were based on the 20–44 year old age range, while the 2006 YAM standards were based on the 20–29 year old age range

cutoff values. Therefore, it was decided that the standard for the lumbar vertebrae shall be based on the 1996 70 % YAM criteria. Conversely, in the proximal femur, it was decided that the 2006 values, which, as was described earlier, are based on individuals in the 20–29 year old age range, shall be used instead. In each case, the −2.5 SD based values were in close agreement to 70 % YAM for women, but displayed some slight variability for men, although no large differences were observed. For this reason, it was decided that the 70 % YAM and −2.5 SD based BMD cutoff values shall be listed together for both the lumbar spine and the proximal femur. Additionally, the cutoff values for both the lumbar spine and proximal femur shall, in principle, use YAM percentage for women, while for men, YAM percentage shall only be used as reference value due to the low number of cases used in calculation. For the radius and second metacarpal bone, however, it has been decided that YAM percentage shall continue to be used to for both men and women and that, due to the large differences between percentage (%) and SD cutoff values (Table 5), only the % based BMD cutoff values shall be listed. Additionally, in order to comply with WHO criteria, the diagnostic criteria for osteoporosis shall be amended from the current below 70 % of YAM standard such that cases in which BMD falls equal to or below either the 70 % YAM or −2.5 SD cutoff values shall be classified as osteoporosis.

5. BMD values for the L1–L4 and L2–L4 spine shall be listed side by side.

Up until now, Japan has used only the BMD values from the L2–L4 spine. However, due to the international use of the L1–L4 spine, it has been decided that both sets of values shall be listed side by side (Table 3). Additionally, values for each vertebra shall not be listed and the data from 2006 shall be used as the standard values for L1–L4.

6. BMD values for the proximal femur and lumbar spine shall be used for men as well.

In the year 2000 revision, it was thought that BMD in the femoral neck was more useful than BMD in the lumbar spine for predicting fractures in men. However, osteoporosis in men diagnosed using only lumbar spinal BMD values also exists. Thus, evaluation of lumbar spine BMD in men is considered to be valuable. However, in the evaluation of lumbar spine BMD, it is necessary to consider that osteoarthritis of the spine and calcification of the abdominal aorta may cause error in BMD value.

7. Notations for the progression of bone loss in spinal X-Ray images shall be removed.

In recent years, due to increased digitalization of radiography it has become difficult to judge the degree of bone loss in spinal X-ray images. As a result, notations marking the progression of bone loss in spinal X-ray images shall be removed.

8. Quantitative ultrasound (QUS)

Although QUS can be used to predict fracture risk and can measure a quantity that correlates with BMD, it cannot

Table 5 The YAM and SD values for BMD measured in Japanese women

Measurement region	Measurement device	BMD (g/cm^2) (YAM ± SD)	SD values corresponding to 80 % of YAM	SD values corresponding to 70 % of YAM
Lumbar spine (L1–L4)	QDR[a]	0.989 ± 0.112	−1.8	−2.6
	DPX[a]	1.152 ± 0.139	−1.7	−2.5
	DCS-900[a]	1.020 ± 0.116	−1.8	−2.6
Lumbar spine (L2–L4)	QDR	1.011 ± 0.119	−1.7	−2.5
	DPX	1.192 ± 0.146	−1.6	−2.4
	DCS-900[a]	1.066 ± 0.126	−1.7	−2.5
	XR	1.040 ± 0.136	−1.5	−2.3
	1X	1.084 ± 0.129	−1.7	−2.5
Femoral neck	QDR[a]	0.790 ± 0.090	−1.8	−2.6
	DPX[a]	0.939 ± 0.114	−1.6	−2.5
	DCS-900[a]	0.961 ± 0.114	−1.7	−2.5
Total hip	QDR[a]	0.875 ± 0.100	−1.8	−2.6
	DPX[a]	0.961 ± 0.130	−1.5	−2.2
	DCS-900[a]	0.960 ± 0.114	−1.7	−2.5
Radius	DCS-600	0.646 ± 0.052	−2.5	−3.7
	XCT-960 (mg/cm^3)	405.36 ± 61.68	−1.3	−2.0
	pDXA	0.753 ± 0.066	−2.3	−3.4
	DTX-200	0.476 ± 0.054	−1.8	−2.6
Second metacarpal bone	CXD (mmA1)	2.741 ± 0.232	−2.4	−3.5
	DIP (mmA1)	2.864 ± 0.247	−2.3	−3.5

[a] Data from the 2006 revision was added and altered to the 1996 data

measure BMD itself. Also, QUS is not an established method for making definitive diagnoses of osteoporosis, even though it has been reported that QUS has utility as an examination procedure in screening for osteoporosis and QUS is a health insurance approved method for measuring bone mineral content in Japan. Therefore, it has been decided that QUS will not be included as part of the diagnostic criteria for osteoporosis.

9. The relevance of low bone mass (osteopenia)

Individuals with low bone mass (osteopenia) have a high risk for developing osteoporosis in the future, and have the potential to receive preventive intervention and, in some cases, drug therapy. In accordance with international standards, individuals with a BMD above −2.5 SD but equal to or below −1.0 SD shall be diagnosed with low bone mass (osteopenia). However, in cases where the patient has fragility fractures other than the vertebra and the proximal femur, a BMD value below the existing 80 % YAM standard (corresponding to −1.7 to 1.8 SD) shall be classified as osteoporosis, and the definition for low bone mass (osteopenia) shall not be used.

10. The severity of osteoporosis

According to the WHO's definition, a BMD value equal to or lower than −2.5 SD combined with the presence of one or more fragility fracture constitutes severe osteoporosis. Although the presence of a fragility fracture certainly increases the risk of a new fracture, as described earlier, the above definition shall simply describe individuals with a high risk of fracture. Also, the high risk of fracture associated with osteoporosis according to Japanese package inserts of medical drugs is thought to arise from patients with the risk factors of low BMD, prevalent fractures, advanced age, a family history of femoral neck fractures and so on. On the other hand, looking at the results of the of the Adequate Treatment of Osteoporosis (A-TOP) Research Group in Japan and the sub-analysis of randomized controlled trials abroad, it is thought that conditions such as a lumbar spine BMD below −3.3 SD [10, 11], the presence of 2 or more prevalent vertebral fractures [10, 12], and prevalent vertebral fractures with a semi-quantitative grade [13] of 3 [12] can be used as a single risk factor for the determining risk factors in identifying osteoporosis patients with a high risk of fracture. Also, despite the fact that fractures existing in the proximal femur can increase the risk of a new fracture, there have been no reports from prospective studies dealing with this point. Most recently,

it has been proposed that the presence of a fracture that increases the mortality of the patient regardless of age should be classified as severe osteoporosis [14]. While the presence of fragility fractures can, regardless of age, increase the mortality of the patient, it is thought that fractures outside of the lumbar spine, femur, rib, pelvis, humerus, and tibia should be considered for severe osteoporosis only in older patients (75 years and above). In reference to the above information, it is recommended that the severity of osteoporosis should be judged from the viewpoint of patient mortality and future fracture risk.

Concluding remarks

The Japanese Society for Bone and Mineral Research and Japan Osteoporosis Society Joint Review Committee for the Revision of the Diagnostic Criteria for Primary Osteoporosis aimed at obtaining international consistency and made a revised edition based on the new findings in 2012. We are going to continue inspection of the validity of those criteria in future.

Conflict of interest None.

Appendix: BMD standard values from the 2006 revision

Calculations were made based on the findings of the Japanese Society for Bone and Mineral Research Committee for the Establishment of BMD Standards. The data necessary for the establishment of these standards was collected in a cross-sectional manner from the results of a DXA study that was carried out from 2004 to 2006 targeting Japanese men and women over the age of 20 years (health screening participants or hospital control). The results are shown below for both men and women, and for the different measurement devices used.

See Tables 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, and 19.

Table 6 YAM for lumbar spine BMD (g/cm^2) (20–44 years of age)

Measurement region	Measurement device	Men			Women		
		N	Age (years) ± SD	YAM ± SD	*N*	Age ± SD	YAM ± SD
L1–L4	QDR	504	32.6 ± 6.8	0.965 ± 0.128	3,510	33.8 ± 7.3	0.989 ± 0.112
	DPX	930	34.5 ± 7.0	1.116 ± 0.150	4,743	36.7 ± 6.0	1.152 ± 0.139
	DCS-900	82	34.8 ± 6.9	1.027 ± 0.112	270	22.7 ± 6.1	1.020 ± 0.116
L2–L4	QDR	553	34.5 ± 7.1	1.024 ± 0.131	5,062	35.3 ± 7.0	1.010 ± 0.119
	DPX	1,084	34.4 ± 7.1	1.138 ± 0.162	6,036	36.8 ± 5.9	1.180 ± 0.143
	DCS-900	123	34.9 ± 6.8	1.050 ± 0.116	464	27.5 ± 8.6	1.066 ± 0.126

Table 7 YAM for proximal femur BMD (g/cm^2) (20–29 years of age)

Measurement region	Measurement device	Men			Women		
		N	Age (years) ± SD	YAM ± SD	*N*	Age ± SD	YAM ± SD
Femoral neck	QDR	162	24.3 ± 2.8	0.828 ± 0.092	863	24.0 ± 2.8	0.790 ± 0.090
	DPX	244	24.7 ± 2.0	1.008 ± 0.123	440	25.1 ± 2.6	0.939 ± 0.114
	DCS-900	62	26.3 ± 2.1	1.027 ± 0.167	267	21.0 ± 2.2	0.961 ± 0.114
Total hip	QDR	203	24.0 ± 2.7	0.955 ± 0.131	915	23.9 ± 2.8	0.875 ± 0.100
	DPX	238	24.8 ± 1.9	1.046 ± 0.135	392	25.2 ± 2.5	0.961 ± 0.130
	DCS-900	59	26.2 ± 2.1	1.030 ± 0.155	265	21.0 ± 2.2	0.960 ± 0.114

Table 8 Women: lumbar spine (L1–L4) BMD standard values (QDR)

Age (years)	*N*	BMD (g/cm^2)	SD
20–24	526	0.975	0.106
25–29	601	0.968	0.108
30–34	554	0.993	0.107
35–39	796	0.998	0.115
40–44	1,033	0.998	0.115
45–49	1,370	0.990	0.128
50–54	1,609	0.916	0.146
55–59	2,012	0.846	0.140
60–64	2,068	0.794	0.137
65–69	2,351	0.772	0.135
70–74	2,527	0.757	0.140
75–79	1,864	0.741	0.152
80–84	1,118	0.743	0.157
85–	657	0.689	0.155
Total	19,086		

Table 9 Women: lumbar spine (L2–L4) BMD standard values (QDR)

Age (years)	*N*	BMD (g/cm^2)	SD
20–24	611	0.993	0.117
25–29	524	0.991	0.112
30–34	714	1.007	0.117
35–39	1,336	1.023	0.119
40–44	1,877	1.013	0.122
45–49	2,743	1.009	0.133
50–54	3,518	0.935	0.146
55–59	3,473	0.861	0.140
60–64	3,034	0.799	0.138
65–69	3,150	0.774	0.135
70–74	3,019	0.767	0.142
75–79	1,802	0.763	0.153
80–84	889	0.762	0.158
85–	366	0.742	0.159
Total	27,056		

Table 10 Women: femoral neck BMD standard values (QDR)

Age (years)	*N*	BMD (g/cm^2)	SD
20–24	492	0.806	0.088
25–29	371	0.769	0.087
30–34	266	0.744	0.097
35–39	262	0.732	0.105
40–44	269	0.703	0.104
45–49	352	0.707	0.112
50–54	857	0.689	0.111
55–59	1,336	0.637	0.099
60–64	1,627	0.618	0.101
65–69	2,390	0.596	0.095
70–74	2,887	0.565	0.094
75–79	2,026	0.538	0.097
80–84	1,309	0.518	0.099
85–	682	0.466	0.104
Total	15,126		

Table 11 Women: total hip BMD standard values (QDR)

Age (years)	*N*	BMD (g/cm^2)	SD
20–24	533	0.889	0.099
25–29	382	0.855	0.098
30–34	273	0.841	0.108
35–39	266	0.838	0.118
40–44	272	0.822	0.121
45–49	357	0.827	0.130
50–54	864	0.799	0.130
55–59	1,339	0.742	0.115
60–64	1,629	0.720	0.115
65–69	2,421	0.693	0.109
70–74	2,910	0.661	0.113
75–79	2,045	0.629	0.116
80–84	1,313	0.591	0.117
85–	682	0.522	0.122
Total	15,286		

Table 12 Women: lumbar spine (L1–L4) BMD standard values (DPX)

Age (years)	*N*	BMD (g/cm^2)	SD
20–24	247	1.141	0.126
25–29	420	1.130	0.131
30–34	792	1.145	0.138
35–39	1,240	1.154	0.137
40–44	2,044	1.159	0.143
45–49	2,236	1.125	0.150
50–54	3,438	1.060	0.161
55–59	5,169	0.966	0.154
60–64	5,629	0.904	0.147
65–69	5,549	0.865	0.142
70–74	5,591	0.821	0.137
75–79	4,700	0.803	0.140
80–84	2,729	0.783	0.142
85–	1,428	0.735	0.141
Total	41,212		

Table 13 Women: lumbar spine (L2–L4) BMD standard values (DPX)

Age (years)	*N*	BMD (g/cm^2)	SD
20–24	309	1.163	0.128
25–29	498	1.150	0.135
30–34	1,006	1.169	0.142
35–39	1,545	1.183	0.141
40–44	2,678	1.191	0.146
45–49	2,964	1.158	0.152
50–54	4,751	1.089	0.166
55–59	7,055	0.995	0.159
60–64	7,390	0.932	0.153
65–69	7,241	0.895	0.151
70–74	7,271	0.855	0.150
75–79	5,899	0.832	0.153
80–84	3,215	0.803	0.153
85–	1,721	0.754	0.150
Total	53,543		

Table 14 Women: femoral neck BMD standard values (DPX)

Age (years)	*N*	BMD (g/cm^2)	SD
20–24	201	0.967	0.115
25–29	239	0.915	0.108
30–34	487	0.886	0.117
35–39	744	0.874	0.113
40–44	1,389	0.885	0.116
45–49	1,518	0.879	0.126
50–54	2,743	0.843	0.128
55–59	3,865	0.789	0.120
60–64	4,310	0.752	0.114
65–69	4,634	0.719	0.109
70–74	5,491	0.677	0.109
75–79	4,927	0.645	0.109
80–84	2,992	0.620	0.114
85–	1,865	0.569	0.114
Total	35,405		

Table 15 Women: total hip BMD standard values (DPX)

Age (years)	*N*	BMD (g/cm^2)	SD
20–24	171	0.996	0.133
25–29	221	0.934	0.122
30–34	473	0.915	0.126
35–39	728	0.912	0.125
40–44	1,348	0.925	0.124
45–49	1,473	0.927	0.138
50–54	2,692	0.898	0.142
55–59	3,794	0.841	0.133
60–64	4,219	0.804	0.126
65–69	4,561	0.771	0.121
70–74	5,393	0.728	0.123
75–79	4,873	0.683	0.123
80–84	2,961	0.651	0.123
85–	1,857	0.591	0.120
Total	34,764		

Table 16 Women: lumbar spine (L1–L4) BMD standard values (DCS-900)

Age (years)	*N*	BMD (g/cm^2)	SD
20–24	230	1.023	0.115
25–29	2	0.974	0.001
30–34	13	0.980	0.158
35–39	10	1.029	0.094
40–44	15	1.001	0.111
45–49	3	1.041	0.070
50–54	2	0.940	0.168
55–59	5	0.955	0.211
60–64	20	0.852	0.117
65–69	24	0.851	0.108
70–74	27	0.817	0.117
75–79	34	0.805	0.084
80–84	16	0.806	0.102
85–	5	0.770	0.124
Total	406		

Table 17 Women: lumbar spine (L2–L4) BMD standard values (DCS-900)

Age (years)	*N*	BMD (g/cm^2)	SD
20–24	255	1.065	0.119
25–29	32	1.045	0.106
30–34	55	1.083	0.139
35–39	49	1.072	0.141
40–44	73	1.062	0.134
45–49	91	1.083	0.155
50–54	203	1.022	0.160
55–59	352	0.910	0.162
60–64	443	0.871	0.162
65–69	553	0.853	0.168
70–74	899	0.839	0.174
75–79	822	0.840	0.181
80–84	529	0.822	0.194
85–	309	0.771	0.199
Total	4,665		

Table 18 Women: femoral neck BMD standard values (DCS-900)

Age (years)	*N*	BMD (g/cm^2)	SD
20–24	241	0.964	0.114
25–29	26	0.935	0.117
30–34	63	0.927	0.130
35–39	121	0.929	0.124
40–44	148	0.927	0.130
45–49	249	0.913	0.129
50–54	287	0.869	0.147
55–59	358	0.803	0.139
60–64	354	0.766	0.125
65–69	340	0.710	0.119
70–74	491	0.638	0.131
75–79	466	0.627	0.135
80–84	299	0.595	0.147
85–	172	0.519	0.151
Total	3,615		

Table 19 Women: total hip BMD standard values (DCS-900)

Age (years)	*N*	BMD (g/cm^2)	SD
20–24	239	0.961	0.111
25–29	26	0.944	0.136
30–34	53	0.929	0.144
35–39	82	0.935	0.133
40–44	106	0.961	0.148
45–49	152	0.950	0.137
50–54	158	0.949	0.152
55–59	185	0.859	0.137
60–64	187	0.819	0.139
65–69	167	0.742	0.132
70–74	262	0.674	0.148
75–79	257	0.640	0.164
80–84	168	0.600	0.157
85–	98	0.494	0.162
Total	2,140		

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