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Studies on osteoporosis in Chile using Isotope – related techniques.

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INTRODUCTION

According to the objectives stated in the last coordination meeting, Bone mass density (BMD) measurements in men and women belonging to a healthy chilean population, were continued. The selection of individuals was made in the manner described in previous reports, using the same exclusion criteria and using the modified WHO questionnaire.

We present in this report the results of BMD measurements performed from the beginning of this study until May 1998. A statistical analysis of the data is presented.

MATERIALS AND METHODS

A. Equipment for BMD measurements.

- Hologic QDR 1000 Bone densitometer
- In - house spine phantom for quality control. Measurements with this phantom gave a C.V. of 0.30 – 0.40 during the period the proyect was performed.

B. Materials

A total of 231 individuals were studied; 64 men and 167 women in the age range 15 – 50 years old, all belonging to the white race. Their anthropomorphic characteristics are shown in table 1A y 1B.

TABLA 1A. ANTHROPOMORPHIC CHARACTERISTICS OF POPULATION STUDIED.

	WOMEN	MEN	Diference
RACE	White	White	
	Mean ± SD	Mean ± SD	Mean ± SE
WEIGHT (Kg)	60.18 ± 11.8	74.4 ± 12.9	14.2 ± 1.75
HEIGHT (cm)	157.9 ± 5.8	170.4 ± 6.1	12.0 ± 0.86
BMI (Kg/cm2)	24.1 ± 4.40	25.5 ± 3.95	1.40 ± 0.6
AREA SPINE (cm2) (L1-L4)	54.92 ± 4.75	63.2 ± 5.94	8.34 ± 0.75
AREA FEMORAL (cm^2) NECK	4.92 ± 0.33	5.61 ± 0.44	0.69 ± 0.054
LENGHT OF FEMORAL NECK (cm)	9.59 ± 0.88	10.31 ± 0.88	0.82 ± 0.003
n	167	64	103

BMI: Body mass Index.

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TABLA 1B. VARIATION COEFFICIENT OF THE MEAN VALUES OF BODY SIZE AND BMD IN THE POPULATION STUDIED.

	MEN	WOMEN
WEIGHT (Kg)	17.3	19.6
HEIGHT (cm)	3.5	3.6
BMI (Kg/m^2)	15.4	18.2
SPINE AREA (cm2)	9.3	8.7
FEMORAL NECK AREA (cm2)	7.9	6.78
LENGHT OF FEMORAL NECK (cm)	8.5	9.2
BMD SPINE	13.5	11.5
BMD FEMORAL NECK	14.1	12.3

C. Methods

BMD was measured in Lumbar Spine (L1 – L4) and in the femoral neck region (right and left). All data were collected in floppy diskettes for processing.

- Curves for BMD vs. Age for spine and both femoral necks; for women and men, were plotted.
- These curves were compared with those obtained from the Hologic data base.
- A correlation between BMD and weight, height, body mass index (BMI) and scanned area in spine and femoral neck, in men and women, was made.
- The statistical analysis proposed by Prentice et al. (1) was applied to our data.
- The statistical tests used were the following:

  1) Statistical correlation between the curves obtained and the theoretical curves.

  2) Multiple regression analysis for association between variables.

  3) Descriptive statistics.

EXCLUSION CRITERIA

Moderate to severe scoliosis

Known chronic illness (past or present) of more than 3 months duration.

Known chronic (>1 month) use of any medication, other than dietary / vitamin supplementation.

Previous low trauma fracture

COMPARISON BETWEEN HOLOGIC DATA AND DATA OF THIS STUDY

1. Comparison of BMD according to age and sex (Table 2,3, 4,6,7) (Figura 1 y 2).

TABLA 2. BONE MINERAL DENSITY ACCORDING TO AGE IN NORMAL WOMEN IN g/cm2.

AGE RANGE	n	LUMBAR SPINE Mean ± SD	FEMORAL NECK Mean ± SD
15-20	19	0.9556 ± 0.1042	0.84260 ± 0.0834
21-25	23	1.0068 ± 0.1056	0.8645 ± 0.1102
26-30	24	0.9772 ± 0.06775	0.7933 ± 0.0844
31-35	29	0.9987 ± 0.1085	0.8349 ± 0.0892
36-40	31	0.9724 ± 0.1306	0.7731 ± 0.0960
41-45	21	0.9889 ± 0.1461	0.7817 ± 0.1016
46-50	19	0.9692 ± 0.1324	0.7957 ± 0.1106
TOTAL	166	0.9834 ± 0.1136	0.8111 ± 0.1002

TABLA 3. BONE MINERAL DENSITY ACCORDING TO AGE IN NORMAL MEN IN g/cm^2.

AGE RANGE	n	LUMBAR SPINE Mean ± SD	FEMORAL NECK Mean ± SD
15-20	8	0.814 ± 0.122	0.9343 ± 0.0915
21-25	4	1.050 ± 0.068	1.0401 ± 0.042
26-30	14	0.9908 ± 0.1298	0.8804 ± 0.156
31-35	13	1.0604 ± 0.1385	0.9251 ± 0.1169
36-40	15	1.0138 ± 0.1615	0.959 ± 0.1567
41-45	8	0.9936 ± 0.1003	0.8731 ± 0.1265
46-50	1	1.0369 ± 0	0.8359 ± 0
TOTAL	63	1.0078 ± 0.1370*	0.9131 ± 0.1288*

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TABLA 4. COMPARISON OF BMD OF RIGHT AND LEFT FEMORAL NECK.

	LEFT FEMORAL NECK (LFN)	RIGHT FEMORAL NECK (RFN)	P VALUE
MEN	0.9049	0.9009	0.703 (NS)
WOMEN	0.8039	0.8160	0.0002 (S)

There is agreement between curves, both for spine and femoral neck, in men and women.

2 The age range in which peak bone mass remains constant was established. This range is 23 – 27 years in all groups (Table 5).

TABLA 5. AGE RANGE OVER WHICH PEAK BMD IS MAINTAINED (YEARS)

	WOMEN	MEN
SPINE	23-27 (1.0068 g/cm^2)	———
FEMORAL NECK	23-27 (0.8645 g/cm^2)	23-27 (1.0401 g/m^2)

TABLE 6A. COMPARISON OF THE HOLOGIC REFERENCE CURVE VS OBTAINED CURVE FOR SPINE IN WOMEN

HOLOGIC REFERENCE CURVE

AGE RANGE	MEAN	SD
15-16	1.010	0.11
17-18	1.015	0.11
19-22	1.019	0.11
23-27	1.040	0.11
28-32	1.047	0.11
33-37	1.041	0.11
38-42	1.024	0.11
43-47	0.999	0.11
48-52	0.967	0.11
53-58	0.892	0.11

OBSERVED CURVE

AGE RANGE	MEAN	SD	Freq.
15-16	0.956	0.104	3
17-18	0.951	0.096	3
19-22	0.972	0.099	13
23-27	1.007	0.106	23
28-32	0.977	0.068	24
33-37	0.999	0.109	29
38-42	0.972	0.131	31
43-47	0.989	0.146	21
48-52	0.969	0.132	19
TOTAL	0.983	0.114	166

STATISTICAL SIGNIFICANCE

AGE RANGE	P Value for the mean	P value for the SD
15-16	0.40	0.56
17-18	0.33	0.97
19-22	0.07	0.43
23-27	0.07	0.61
28-32	< 0.0001*	< 0.001*
33-37	0.01	0.55
38-42	0.03	0.15
43-47	0.54	0.08
48-52	0.92	0.24

* Differences are statistically significant after bonferroni correction for Multiple comparisons.

TABLE 6B. COMPARISON OF THE HOLOGIC REFERENCE CURVE VS OBSERVED CURVE FOR SPINE IN MEN

HOLOGIC REFERENCE CURVE

AGE RANGE	MEAN	SD
15-16	1.01	0.11
17-18	1.05	0.11
19-22	1.091	0.11
23-27	1.091	0.11
28-32	1.091	0.11
33-37	1.091	0.11
38-42	1.091	0.11
43-47	1.068	0.11
48-52	1.053	0.11
53-58	1.038	0.11

OBSERVED CURVE

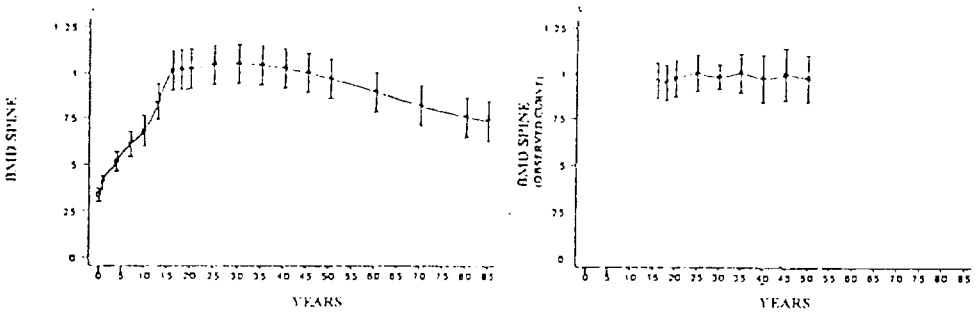
AGE RANGE	MEAN	SD	Freq.
15-16	1.053	0.000	1
17-18	0.815	0.122	4
19-22	1.043	0.086	3
23-27	1.051	0.068	4
28-32	0.991	0.129	14
33-37	1.060	0.139	13
38-42	1.014	0.162	15
43-47	0.994	0.100	8
48-52	1.037	0.000	1
TOTAL	1.008	0.137	63

STATISTICAL SIGNIFICANCE

AGE RANGE	P Value for the mean	P value for the SD
15-16	-	-
17-18	0.03	0.62
19-22	0.38	0.82
23-27	0.32	0.5
28-32	0.008	0.56
33-37	0.41	0.32
38-42	0.07	0.02
43-47	0.06	0.87
48-52	----	----

FIGURE N° 1. COMPARISON OF THE HOLOGIC REFERENCE CURVE IN SPINE VS OBSERVED CURVE.

WOMEN



MEN

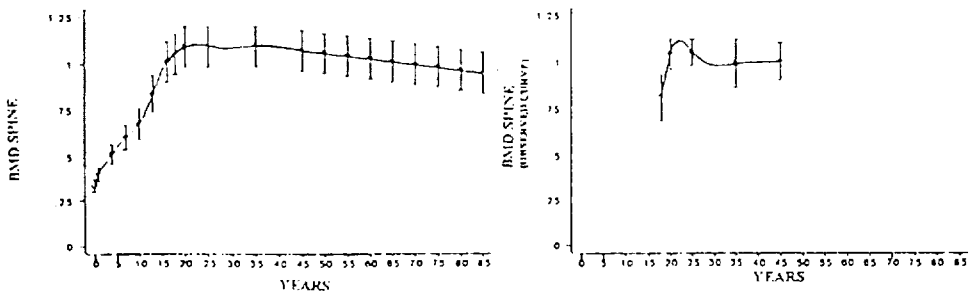


TABLE 7A. COMPARISON OF THE HOLOGIC REFERENCE CURVE VS OBSERVED CURVE FOR FEMORAL NECK IN WOMEN

HOLOGIC REFERENCE CURVE

AGE RANGE	MEAN	SD
15-22	0.895	0.1
23-27	0.894	0.1
28-32	0.886	0.1
33-37	0.871	0.1
38-42	0.850	0.1
43-47	0.826	0.1
48-52	0.797	0.1
53-58	0.766	0.1

OBSERVED CURVE

AGE RANGE	MEAN	SD	Freq.
15-22	0.843	0.083	19
23-27	0.865	0.110	23
28-32	0.793	0.084	24
33-37	0.835	0.089	29
38-42	0.773	0.096	31
43-47	0.782	0.102	21
48-52	0.795	0.111	19
TOTAL	0.811	0.100	166

STATISTICAL SIGNIFICANCE

AGE RANGE	P Value for the mean	P value for the SD
15-22	0.008	0.26
23-27	0.150	0.45
28-32	< 0.0001*	0.19
33-37	0.01	0.14
38-42	< 0.0001*	0.48
43-47	0.05	0.91
48-52	0.78	0.48
53-58	—	—

* Differences are statistically significant after bonferroni correction for Multiple comparisons.

TABLE 7B. COMPARISON OF THE HOLOGIC REFERENCE CURVE VS OBSERVED CURVE FOR FEMORAL NECK IN MEN

HOLOGIC REFERENCE CURVE

AGE RANGE	MEAN	SD
15-22	0.979	0.11
23-27	0.958	0.11
28-32	0.936	0.11
33-37	0.915	0.11
38-42	0.894	0.11
43-47	0.873	0.11
48-52	0.851	0.11
53-58	0.830	0.11

OBSERVED CURVE

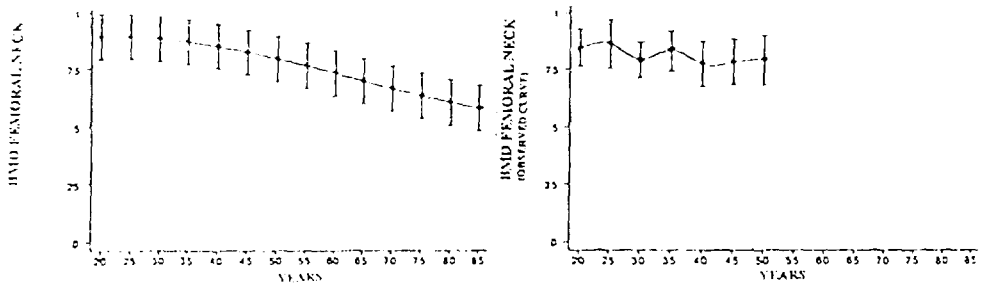
AGE RANGE	MEAN	SD	Freq.
15-22	0.934	0.091	8
23-27	1.040	0.042	4
28-32	0.880	0.116	14
33-37	0.925	0.117	13
38-42	0.906	0.157	15
43-47	0.873	0.127	8
48-52	0.836	0.000	1
TOTAL	0.911	0.125	63

STATISTICAL SIGNIFICANCE

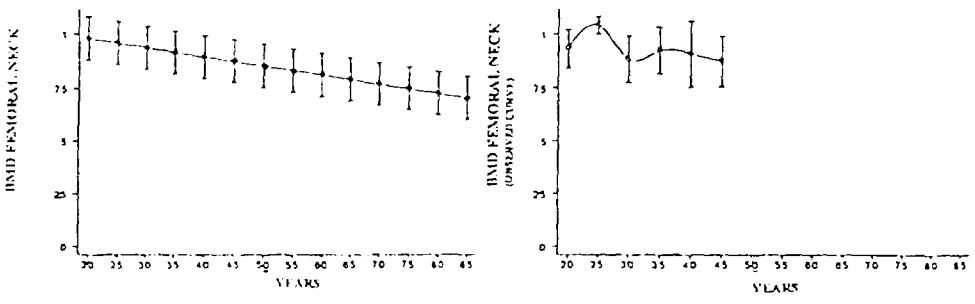
AGE RANGE	P Value for the mean	P value for the SD
15-22	0.17	0.63
23-27	0.02	0.11
28-32	0.07	0.89
33-37	0.87	0.89
38-42	0.88	0.05
43-47	0.94	0.61
48-52	-	-
53-58	-	-

FIGURE N° 2. COMPARISON OF THE HOLOGIC REFERENCE CURVE IN FEMORAL NECK VS OBSERVED CURVE.

WOMEN



MEN



3. The distribution of Z and T values for the population studied was established according to the Hologic data base (Table 8).

A predominance of negative values was observed. This was true for spine, both in men and woman, but only observed for women in fermoral neck.

This indicates a tendency to lower values of BMD in the population studied with respect to the Hologic data base

TABLA 8. VALUES OF Z AND T SCORES IN NORMAL MEN AND WOMEN.

	VALUE OF Z SCORE IN NORMAL MEN AND WOMEN	(HOLOGIC DATA BASE)
	SPINE Z SCORE Mean ± SD	FEMORAL NECK Z SCORE Mean ± SD
WOMEN	-0.3344 ± 1.0451 (65 % [-] S)	-0.5224 ± 1.0157 (68 % [-] S)
MEN	-0.6465 ± 1.2299 (70 % [-] S)	0.0213 ± 1.202 (48 % [-] NS)

	VALUE OF T SCORE IN NORMAL MEN AND WOMEN		(HOLOGIC DATA BASE)	
	SPINE T SCORE Mean ± SD		FEMORAL NECK Z SCORE Mean ± SD	
	15-50 years	20-30 years	15-50 years	20-30 years
WOMEN	-0.6001 ± 1.02	-0.5865 ± 0.83 (S)	-0.904 ± 1.013	-0.4416 ± 1.05 (S)
MEN	-0.8358 ± 1.191	-0.5884 ± 1.03 (S)	-0.5830 ± 1.198	-0.4308 ± 1.14 (NS)

STUDY OF THE CORRELATION OF BMD WITH THE INDICATORS OF CORPORAL SIZE.

Weight
Height
BMI
Scanned area Spine and Femoral neck

a) Lumbar spine

A statistically significant correlation was found between BMD of the lumbar spine with the following parameters:

Scanned area
Weight
Height
Bone Mass Index (BMI)

	MEN	WOMEN
Δ 1 cm2 area	⇒ Δ 0.0076 g/cm2	Δ 0.0066 g/cm2
Δ 1 kg weight	⇒ Δ 0.0037 g/cm2	Δ 0.004 g/cm2

b. Femoral necks

A statististically significant correlation was found between BMD of both femoral necks with the following parameters:

1. Weight
2. Body mass index (BMI)

No correlation was found with height or scanned area for men or women.

1 kg ⇒ Δ 0.002 g/cm2 for both men and women.

APPLICATION OF THE METHOD PROPOSED BY PRENTICE ET AL (1).

Evaluation of the proportionality between the area considered in the calculation of BMD and BMC (Bone mineral content).

A regression between the logarithm of the area and the logarithm of BMC is performed. If the slope of the regression curve is significantly different from "1", this means that the normalization with respect to area does not correct adequately other factors which are related to corporal size.

Slope of the regression curve

Women		Men	
Spine	Fem. Neck	Spine	Fem. Neck
1.35 ($p<0.0001$)	0.81 (NS)	1.48 ($p<0.0001$)	0.87 (NS)

SUMARY OF THE MAIN FINDINGS OF THIS STUDY

1. It has been difficult to find individuals which present the characteristics necessary to be included in this study. This has been specially true for men in all age ranges, and more so in the extreme age ranges. The number of individuals in these ranges need to be increased.

2. The anthropometric parameters of the population studied show homogeneous variation coefficients in men and women. The lowest variation coefficients are found for height and scanned areas. Variability between men and women is also significant, with its lowest value for the area of the femoral neck.

3. Plots of BMD vs Age both Hologic and observed data were in agreement. However, a significantly predominance of negative Z score was found specially in Spine in. This might indicate that the chilean population has a tendency to lower BDM values than those incorporated into the Hologic data base.

4. Peak bone mass is reached and maintained in the third decade of life in the chilean population.

5. BMD was higher in men than in women. Women shows higher BMD in the right femoral neck.

6. Body size- related paramaters have a significant and positive correlation with BMD. This might be due to:

a) The fact that normalization for bone area is not enough to correct for the influence of tridimensional bone size, which in turns depends on corporal size or others body size related factors (body composition) (2,3).

b) Greater body size is actually associated with higher BMD.

7. Body size- related parameters affect spine BDM differently than femoral neck BMD. Spine BMD seems to be influenced to a higher degree by bone size (bone area) and its variations might not reflect true changes in BMD. Femoral neck BMD is more dependent on weight and its variation might reflect true changes in BMD due to a greater mechanical load.

CONCLUSIONS

1. Because of the influence of body size – related parameters in the values of BMD obtained with conventional desintometers, it is necessary to consider them both in the clinical and epidemiological interpretation of BMD measurements.

2. It is necessary to validate locally the data bases provided by the manufacturers of bone desintometers. This implies that the anthropomorphic parameters for the individuals included in those data bases must be known and they should be compared with the parameters of the local population.

3. In a comparative study such as this, the influence of anthropomorphic and perhaps body composition characteristics of the population studied should be globally evaluated, before drawing conclusions about BMD in these populations. May be interesing to consider all, BMC, BMD and Bone Area to determine wheter real change occur in bone variables in the populations studied and to analize the relation between this variables in the different countries.

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