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Low bone mineral density in middle-aged women: a red flag for sarcopenia

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Abstract

Objective: This study evaluated whether low bone density, a condition related to aging, is associated with low muscle mass, a surrogate for sarcopenia, and whether it could be used as a marker of the condition.

Methods: We studied 483 women aged 35 to 69 years old who appeared healthy and attended a preventive gynecological examination. Dual-energy X-ray absorptiometry was used to measure bone mineral density (BMD) and regional body composition. BMD was assessed using the *T*-score. Low appendicular lean mass (aLM) adjusted by height (aLM index) was defined according to Baumgartner et al ($<5.45\,kg/m^2$). The association of low aLM index with bone mass was evaluated with a binary logistic regression using a cutoff point on the receiver operating characteristic curves for the *T*-score of −1.5.

Results: The participants had a mean age of 54.7 ± 9.1 years, body mass index of $24.6 \pm 3.6\,kg/m^2$, aLM index of $5.9 \pm 0.6\,kg/m^2$ (22.6% showed sarcopenia), abdominal fat percentage of $44.0 \pm 9.1\%$, and *T*-score of -0.48 ± 0.97. In the logistic regression model, we found that low BMD implied a significant risk for sarcopenia (odds ratio [OR] 1.77; 95% CI, 1.02-3.06). In contrast, excess body weight was a protective factor (OR 0.12; 95% CI, 0.06-0.25). Neither age nor abdominal fat percentage, however, influenced the likelihood of sarcopenia in these women.

Conclusions: A BMD *T*-score below −1.5 suggests low muscle mass in middle-aged women, which is a central element in the diagnosis of sarcopenia. Early diagnosis provides the opportunity to introduce preventive and therapeutic options.

Key Words: Aging – Bone mineral density – Osteopenia – Sarcopenia – Women.

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Antecedentes y objetivo

- La sarcopenia se asocia a mayor riesgo de caidas, fracturas, E crónicas, discapacidad y mortalidad.
- El dg precoz facilita medidas terapéuticas tempranas para reducir el riesgo
- La sarcopenia también se asocia a osteoporosis
- Una baja densidad mineral ósea (DMO) es un hallazgo frecuente en mujeres de mediana edad
- Por ello se investigó si la baja DMO se asocia con una mayor probabilidad de baja masa muscular en mujeres chilenas aparentemente sanas

Población y Método

- 483 mujeres chilenas aparentemente sanas de 35 a 69 años que concurrieron a consulta ginecológica preventiva en clínica privada.
- Mediciones antropométricas
- DEXA: masa ósea, masa muscular de extremidades y masa grasa.
- Se calculó IMMA =MMA/talla^2
- IMMA bajo <5,45 kg/m2 (*Baumgarten*)

TABLE 1. *Body composition according to muscle mass*

	All women (*n*: 483, 100%)	Normal muscle mass[a] (*n*: 374; 77.4%)	Low muscle mass[b] (*n*: 109; 22.6%)	*P*
Age (y)	54.7 ± 9.1	54.3 ± 9.1	56.0 ± 9.1	<0.078[c]
BMI (kg/m^2)	24.6 ± 3.6	25.2 ± 3.5	22.6 ± 3.2	<0.001[d]
aLM (kg)	15.3 ± 1.9	15.9 ± 1.6	13.3 ± 1.4	<0.001[d]
aLM index (kg/m^2)	5.9 ± 0.6	6.1 ± 0.5	5.1 ± 0.3	<0.001[c]
Total fat (kg)	24.6 ± 7.1	25.4 ± 7.2	22.1 ± 6.3	<0.001[c]
Fat mass index (kg/m^2)	9.5 ± 2.8	9.8 ± 2.8	8.6 ± 2.5	<0.001[d]
% Android fat (abdominal)	44.0 ± 9.1	44.5 ± 8.9	42.3 ± 9.4	<0.021[d]
Femoral neck BMD	0.920 ± 0.117	0.934 ± 0.114	0.882 ± 0.118	<0.001[c]
Mean *Z*-score	0.39 ± 0.85	0.43 ± 0.84	0.26 ± 0.88	<0.001[c]
Mean *T*-score	−0.48 ± 0.97	−0.39 ± 0.95	−0.80 ± 0.98	<0.001[c]

[a]aLM index ≥5.45 kg/m^2.
[b]aLM index <5.45 kg/m^2.
[c]Student's *t* test
[d]Mann–Whitney *U* test.
aLM, appendicular lean mass.

TABLE 2. *Factors associated with muscle mass (aLM index)*

	All women	Muscle mass (aLM index)		OR	95% CI
		Normal	Low[a]		
No. of women (%)	483 (100.0)	374 (77.4)	109 (22.6)		
No. of women with low BMD[b]	154 (31.9)	107 (28.6)	47 (43.1)	1.89	1.22-2.94
Age >50 y	338 (70.0)	257 (68.7)	81 (74.3)	1.32	0.81-2.13
Higher android fat (≥45.7%)[c]	242 (50.1)	199 (53.2)	43 (39.4)	0.57	0.37-0.89
Overweight/obesity (BMI ≥25.0)	192 (39.8)	179 (47.9)	13 (11.9)	0.15	0.08-0.27

[a]Low muscle mass: aLM index $<5.45\,kg/m^2$.
[b]T-score < -1.0.
[c]Median of the percentage of android fat.
aLM, appendicular lean mass; BMI, body mass index.

Tabla 3. Regresión logística para Factores asociados a baja masa muscular

	OR	95%CI	p
T score<-1.5	1.77	1.02-3.06	0.041
Predominio grasa androide	1.49	0.89-2.52	0.133
>50 años	1.31	0.78-2.21	0.306
IMC>25kg/m2	0.12	0.06-0.25	<0.001

Discusión y Conclusiones

- Prevalencia sarcopenia 22,6% > que datos previos.
- Tener DMO T<-1,5 implica > probabilidad de sarcopenia.
- La explicación biológica radica en la conversación permanente entre músculo y hueso, con producción de citoquinas por el músculo que influyen en el metabolismo óseo y a la inversa el hueso produce esclerostina que induce reducción muscular
- Cuando se encuentra osteopenia de cadera (Tscore<-1.5), en mujeres de mediana edad, se impone no solo la prevención de la osteoporosis sino también la evaluación de la masa y función muscular. Ello permitirá tomar las medidas terapéuticas oportunamente, lo que redundará en disminución de riesgo de E Crónicas futuras y una mejor calidad de vida.

Clinical Interventions in Aging

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ORIGINAL RESEARCH

Reference values of hand-grip dynamometry and the relationship between low strength and mortality in older Chileans

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Aim: This study was aimed to set reference values of hand-grip strength by age and sex and validate cut points for risk of functional limitation and mortality in older Chileans.

Methods: This was a pooled analysis of four studies including 6,426 people ≥60 years of nondependent community-dwelling Chileans. After exclusion criteria, the final sample included 5,250 subjects, from whom 2,193 were followed to study all-cause mortality associated with low hand-grip strength. Face-to-face interviews registering sociodemographic characteristics, self-reported chronic diseases, and functional limitations were conducted. Anthropometric measurements and observed mobility were performed by trained professionals. Hand-grip strength was measured with a hand dynamometer T-18 (Country Technology, Inc.) before 2008 or with JAMAR brand from 2008 onwards. Percentiles were calculated through descriptive analysis and quantile regression models for specific groups of age and sex. Adjusted Cox regression hazard models

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Antecedentes y objetivo

- La fuerza muscular es un importante determinante de función física en personas mayores.
- Varios estudios han mostrado estrecha asociación entre fuerza y masa muscular, y que la combinación de sarcopenia y disminución de fuerza muscular contribuye significativamente a la declinación funcional y la independencia en PM.
- Actualmente la dinamometría es ampliamente usada para el Dg de sindromes geriátricos como sarcopenia, fragilidad y dismobilidad.
- El objetivo de este estudio fue desarrollar valores de referencia de dinamometría de mano y validar puntos de corte para riesgo de limitación funcional y mortalidad en personas mayores chilenas

Población y método

Análisis agrupado de 4 estudios de chilenos ≥60a, no dependientes, viviendo en la comunidad, con mediciones basales de dinamometría de mano efectuadas entre 2000 y 2015

Muestra : 6,426 personas≥60 a (min–max: 61–101 years):

Alexandros:3198
PACAM :1324
HTS mayor: 439
ENADEAM:1465

Criterios de exclusión: IMC<20 o >40; osteoartritis mano, cancer, discapacidad, EPOC

Total excluidos 1176 **muestra final 5250**

Muestra para seguimiento 2193

Evaluación por profesionales entrenados y estandarizados

Antropometría: peso, talla, alt de rodilla, circunf de cintura, caderas, brazo y pantorrilla

Movilidad observada: TUG, velocidad de marcha, agacharse, sostener 5kg etc

Dinamometría con dinamómetros calibrados. Mediciones con mano dominante, registrando la marca mayor de 3, con los sujetos sentados con antebrazos apoyados en los brazos de la silla o mesa pidiéndoles ejercer la mayor fuerza posible

Table 2 Normative values for hand-grip strength derived from quantile regression models, according to age and sex (n=5,255)

Percentiles	Percentiles in kg (95% CI) by age group[a]					
	60–64.9 years	65–69.9 years	70–74.9 years	75–79.9 years	≥80 years	Total
Men						
5th[b]	22 (22–22)	20 (20–20)	20 (20–20)	19.6 (19.5–19.6)	16.0 (15.8–16.1)	20.1 (20.0–20.1)
10th[b]	25.7 (25.6–26.8)	23.8 (23.7–23.8)	20 (20–20)	20.6 (20.5–20.6)	20 (20–20)	22.5 (22.4–22.6)
25th[b]	30.4 (30.4–30.5)	28.2 (28.2–28.3)	25.9 (25.8–26.0)	25.2 (25.1–25.3)	21.4 (21.3–21.5)	27.0 (26.9–27.1)
50th[b]	37.9 (37.8–38.0)	34.5 (34.5–34.6)	31.6 (31.4–31.7)	29.7 (29.6–29.8)	26.3 (26.2–26.5)	32.7 (32.6–32.9)
75th[b]	41.8 (417–42.0)	39.5 (39.4–39.6)	37.5 (37.4–37.7)	35.5 (35.5–35.5)	31.4 (31.2–31.7)	37.9 (37.8–38.1)
90th[b]	47.9 (47.8–48.0)	43.5 (43.4–43.6)	43.7 (43.4–44.0)	40 (40–40)	37.5 (37.2–37.7)	42.8 (42.7–43.0)
95th[b]	49.4 (49.3–49.5)	46.5 (46.4–46.6)	46.7 (46.4–47.0)	47.0 (46.9–47.1)	43.8 (43.2–44.4)	46.9 (46.8–47.0)
Total men	314	737	373	307	225	1,956
Women						
5th[b]	11.3 (11.3–11.4)	9.0 (9.0–9.1)	10.0 (10.0–10.0)	10.0 (10.0–10.0)	7.0 (7.0–7.1)	9.5 (9.45–9.5)
10th[b]	13.4 (13.5–13.6)	11.0 (11.0–11.1)	11.6 (11.5–11.7)	10.1 (10.1–10.1)	9.4 (9.4–9.5)	11.2 (11.1–11.2)
25th[b]	17.7 (17.7–17.8)	15.6 (15.6–15.7)	16.2 (16.1–16.3)	13.5 (13.5–13.6)	11.7 (11.6–11.8)	15.3 (15.2–15.3)
50th[b]	21.7 (21.7–21.7)	20.0 (20.0–20.0)	20.0 (20.0–20.0)	18.0 (18.0–18.0)	15.5 (15.3–15.6)	19.3 (19.2–19.4)
75th[b]	26.0 (26.0–26.0)	24.0 (24.0–24.0)	25.1 (25.0–25.2)	21.4 (21.4–21.5)	19.4 (19.3–19.5)	23.4 (23.4–23.5)
90th[b]	30.0 (30.0–30.0)	27.8 (27.8–27.8)	30.9 (30.9–31.0)	28.9 (28.8–28.9)	24.1 (23.9–24.3)	29.8 (29.8–29.81)
95th[b]	32.0 (32.0–32.0)	30.2 (30.1–30.2)	34.6 (34.5–34.7)	32.0 (32.0–32.0)	28.7 (28.5–29.0)	31.3 (31.3–31.33)
Total women	535	1,129	688	498	444	3,294

Notes: The percentile values are derived from the quantile regression models for the exact ages shown. [a]Binomial exact 95% CI. [b]Test for trend across ordered groups: $p<0.0001$ in both sexes.

Abbreviation: CI, confidence interval.

Table 3 Functional and physical performance according to dynamometry

Variables	din > p25 n=3,965	din ≤ p25 n=1,285	Total n=5,250	*p*-value
Calf circumference[a] (cm) mean ± SD	33.9±5.7	33.0±6.1	33.7±5.8	0.0004
Mid-arm circumference[a] (cm) mean ± SD	29.2±4.8	28.3±3.8	29.0±4.7	<0.0001
IADL[b] %	28.3	65.0	32.7	0.001
Gait speed (m/sec) mean ± SD	0.88±0.23	0.75±0.25	0.87±0.23	0.0001
TUG[a] (seconds) mean ± SD	9.5±4.0	10.3±3.3	9.6±3.8	0.0001
Bending[a,c] (seconds) mean ± SD	1.87±1.41	2.42±1.44	1.94±1.43	<0.0001
Grasping[b,d] %				0.001
No limitation	81.6	76.6	80.8	
Limitation	17.5	20.2	17.9	
Cannot do it	0.91	3.5	1.3	
Holding[b] 5 kg %				<0.0001
No difficulty	95	79.1	93.5	
With difficulty	3.4	10.5	4	
Cannot do it	1.6	10.5	2.4	

Notes: [a]Two-sample mean-comparison test; [b]Pearson χ^2; [c]time to pick up a pencil from the floor; [d]grasping a coin from a table.
Abbreviations: din, dynamometry; p25, 25th percentile; SD, standard deviation; IADL, Instrumental Activities of Daily Living; TUG, Timed Up and Go.

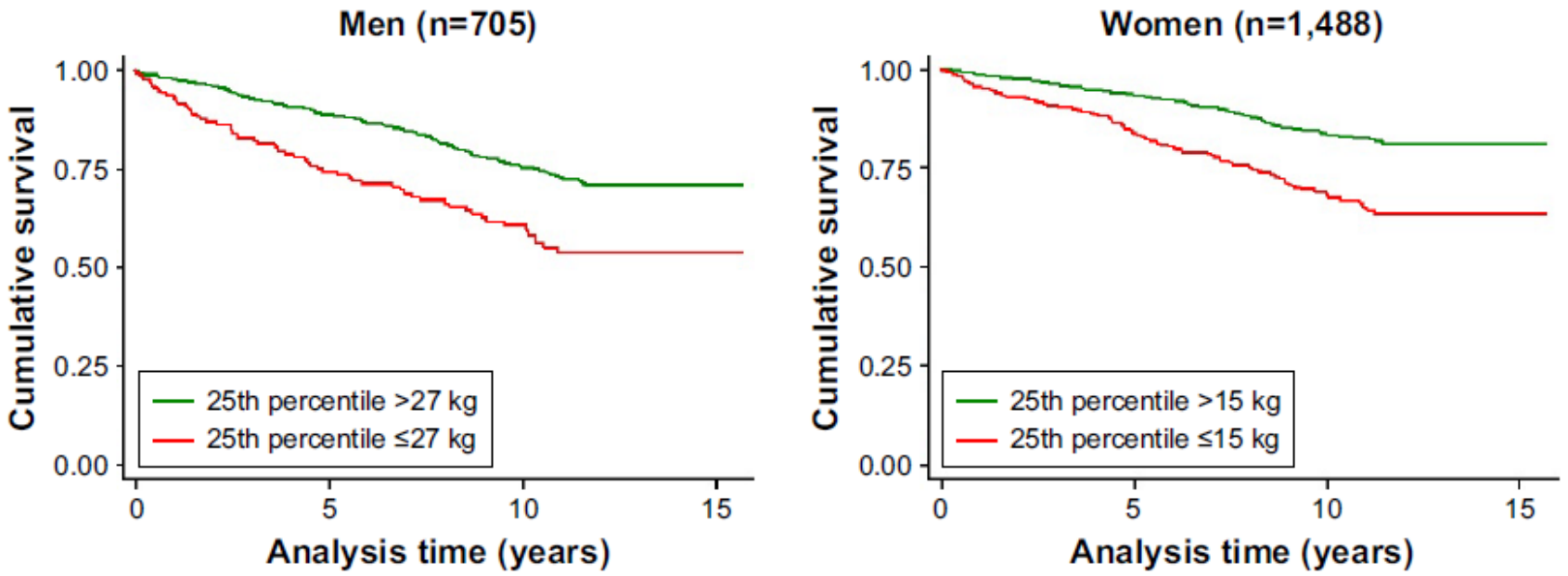

Figure 2 Kaplan–Meier survival estimates by hand-grip strength and sex.
Note: Log-rank test for equality of survival functions: $p<0.0001$.

Table 4 Proportional hazard models for 15 year mortality risk according to hand-grip strength (n=2,193)

Variables	Model 1	Model 2	Model 3	Model 4
	HR (95% CI)	HR (95% CI)	HR (95% CI)	HR (95% CI)
≤25th percentile = 15/27 kg*	2.03 (1.66–2.48)	1.43 (1.16–1.76)	1.39 (1.13–1.72)	1.39 (1.13–1.71)
Age groups (years)				
70–79.9 years		3.61 (2.91–4.47)	3.54 (2.85–4.38)	3.53 (2.85–4.38)
≥80 years		7.97 (6.17–10.30)	7.79 (6.02–10.08)	7.70 (5.94–9.98)
Women		0.61 (0.50–0.74)	0.62 (0.52–0.75)	0.63 (0.52–0.76)
BMI categories				
25–29.9 (kg/m^2)			0.83 (0.67–1.04)	0.81 (0.65–1.01)
≥30 (kg/m^2)			0.81 (0.63–1.04)	0.77 (0.60–0.99)
Number of chronic diseases				
1				0.93 (0.70–1.24)
2				0.99 (0.74–1.33)
3+				0.95 (0.70–1.27)
Current smoker				1.21 (0.90–1.64)
Past smoker				1.08 (0.88–1.32)

Discusión y conclusiones

- Los valores de referencia de dinamometría se calcularon a través de modelos de regresión quantílicas, según edad y sexo, en una gran muestra, seleccionándose el ***p25 como el punto de corte de riesgo (M=15 kg y H=27Kg)***.
- Considerando los diferentes outcomes asociados a dinamometría, como funcionalidad física, discapacidad, institucionalización y mortalidad, es importante validar valores de referencia y puntos de corte para una población de características similares en términos de edad, y composición étnica
- Tener puntos de corte validados para la población chilena permite la incorporación de este indicador en la evaluación gerátrica efectuada en la atención primaria, para identificar adultos mayores en riesgo de sarcopenia, fragilidad y limitación funcional.
- Adicionalmente tiene implicancias para intervenciones y programas futuros, ayudando a optimizar la identificación de sujetos en riesgo, así como la evaluación de estrategias tendientes a mantener la funcionalidad.