

Osteoporosiaren prebentzio eta tratamendurako Jarduera Fisikoa

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Hezurraren Biologia: Ehun dinamikoa

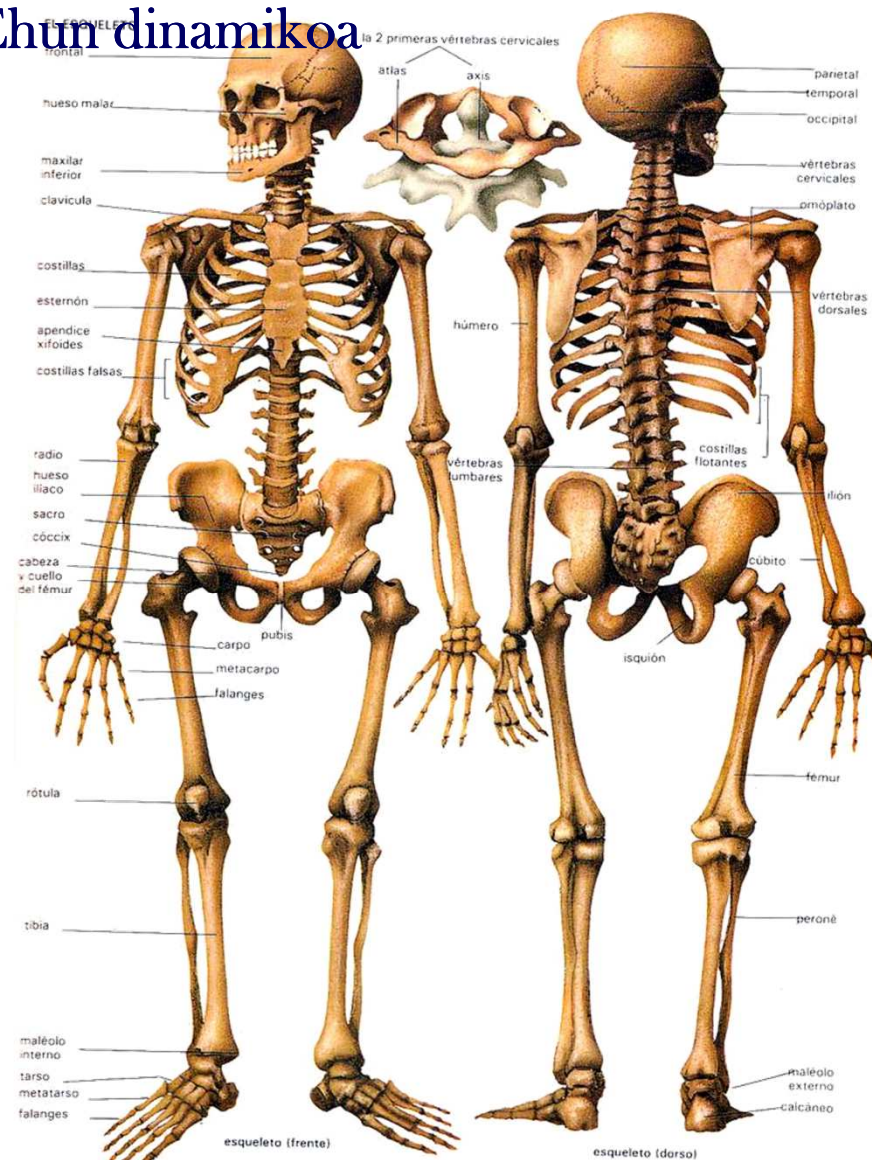
Zurrun
tasuna

Funtzioa:
Euskarria
eta apurtu
gabe indar
egitea

Deformazioa
erresistentia

Egokitz
ea

Hezurraren indarra ehun
kopuruaren arabera da (BMC),
materialaren osaketaren arabera
eta material horren antolaketa
geometrikoaren eta mikro
arkitekturaren arabera



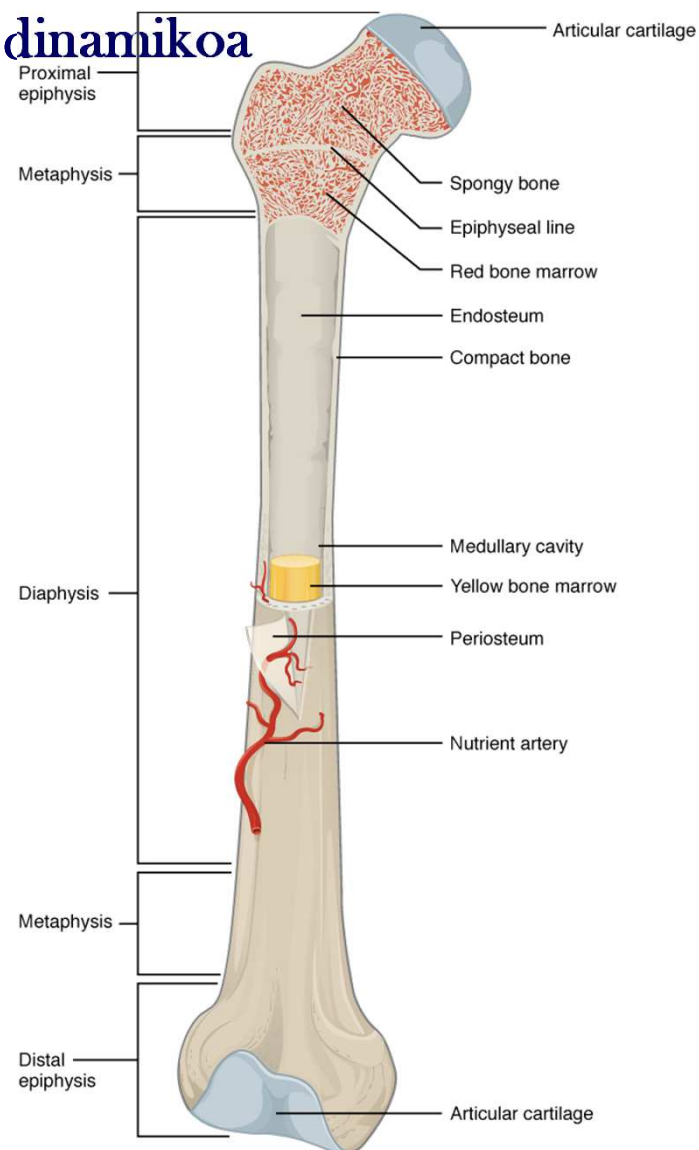
Buckwalter. *JBJS* 1995; 77: 1256-1275

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Hezuraren Biologia: Ehun dinamikoa

Hezurak duen trakziorako erresistentzia burdinurtuaren antzekoa da. Hala ere, 3 aldiz arinagoa da eta 10 aldiz malguagoa, eta aldaketa fisiologiko eta mekanikoei modu jarraituan egokitze gaitasuna du.

Hezurra etengabe aldatzen da hormonien seinaleei eta seinale mekanikoei erantzunez



Buckwalter. *JBJS* 1995; 77: 1256-1275

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Hezuraren egitura: Hezur kortikal eta arola

Hezur kortikalak (konpaktoa) eta arolak (trabekularra) osaketa berdina dute baina BMDan ezberdinak dira

Hezur kortikalaren konpresio indarra 10 aldiz handiagoa da. Hezurdura helduaren %80 da eta muina eta hezur trabekularra inguratzen du

Ornoak, pelbiseko hezurak eta hezur luzeen metafisiek hezur trabekularren zati handia dute, *hezur kortikalaren* geruza txiki batez babestutakoak. *Hezur kortikalak* hezur luzeen diafisia osatzen du



FIG. 1

Longitudinal section of a human phalanx, showing the central marrow space and the distribution of cortical and cancellous bone in a typical tubular (long) bone. The metaphyses contain most of the cancellous bone. The cortical bone decreases in thickness from the mid-part of the diaphysis to the metaphyses, where the plates of cancellous bone are arranged to support the subchondral bone. Large long bones, such as the femur, tibia, and humerus, have the same structural pattern. (Reprinted, with permission, from: Buckwalter, J. A., and Cooper, R. R.: Bone structure and function. In Instructional Course Lectures. The American Academy of Orthopaedic Surgeons. Vol. 36, p. 29. Park Ridge, Illinois, The American Academy of Orthopaedic Surgeons, 1987.)

Buckwalter. *JBJS* 1995; 77: 1256-1275

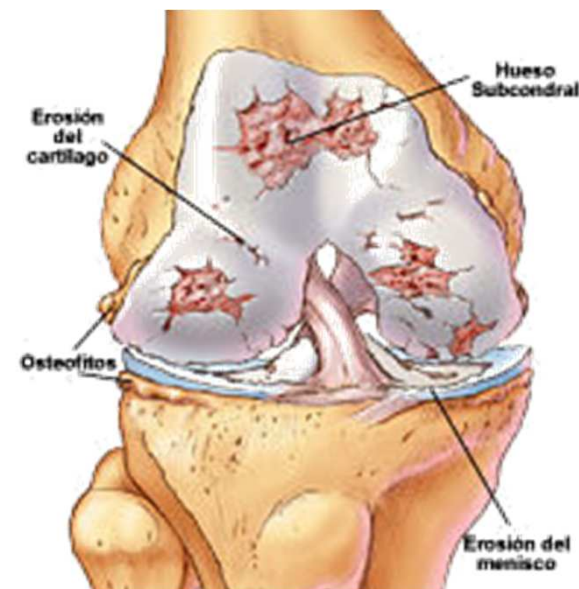
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Hezuraren egitura:

Hezur luzeetan diafisiaren hezur kortikalak bihurtzeko eta tolestari erresistentzia handiena ematen die.

Metafisi eta diafisian masa kortikal subkondrala, hezur trabekularrarekin eta kartilagoarekin batera deformazio handiagorako aukera ematen dute eta inpaktuak xurgatzen dituzte

Hezuraren egitura ezarritako kargei emandako erantzunaren, hormonaren eraginaren eta abarren arabera aldatzen da (hezur trabekularrak jardueraren metaboliko handiagoa du)



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Hezurra

Osagai organikoak (%35) eta inorganikoak (%65) eta ura, hezur matrizea betetzen duten zelula-prozesu konplexuen sistema landu batean

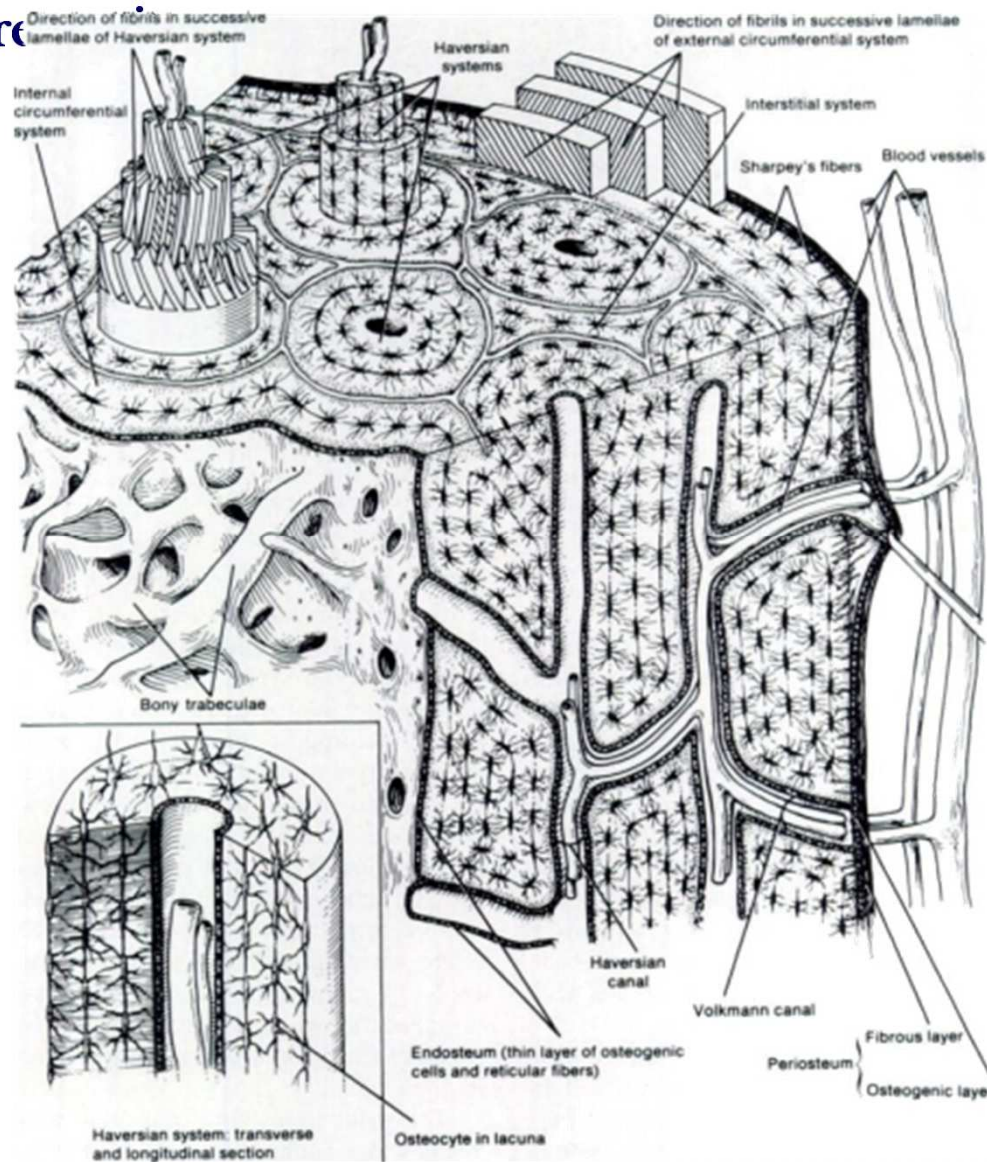
Hezuraren propietate mekanikoak kolageno matrizearen ezaugarriek eta mineralizazio graduak zehazten ditu ($\text{Ca}_{10}(\text{PO}_4)_6$)

Malgutasuna.

Colágeno zuntzak, hezur proteinare n %80

Mineralizazioa:

Kaltzioa, Magnesioa, fluorra, O₂ eta hidrogenoa



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Modelazioa eta birmodelazioa

Hezur ehunaren zelulak HSC eta MSCek sortzen dituzte, eta hauek dira:

- Osteozitoak, osteonetan daudenak
- Osteoblastoak formazioaz arduratzen direnak
- Osteoklastoak berriz xurgatu eta ezabatzen dutenak
- Bone-lining cells:** osteoklastoen jarduera estimulatzeko dute

Osteozitoek hezurren materiala egonkortzen dute, mikrofakturak hautematen dituzte, hezurren ehunaren deformazioen kuantitateari eta banaketari erantzuna ematen diote eta minerala erregulatzen eta hezurren arkitekturan inplikaturik daude.

Osteoblasto eta osteoclastoek beharren arabera hezur kortikala eta arola sortzen dute (modelazioa)

Osteoblastoa
kmatrize
organikoaren
sintesia eta
jariatzea

Osteoclastoa
kHezurak
birxurgatzen
dituzte hezur
espazioa
azidotuz

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Mineralizazioa: Hezurren zurruntasuna handitu

Birmoldatzea:
Osteoklastoek
hezurra birxurgatu
eta osteoblastoek
barrunbea bete (3-
4 hilabete)

Heldu batek
urtero bere hezur
ehunaren %10-30
artean berritzen du

Hezurren birmoldatzean
hezurrean ezarritako
indarraren magnitudean
eragina dute, indar
horiek ezartzeko
maiztasunean eta
jarraitzen duten
norabidean

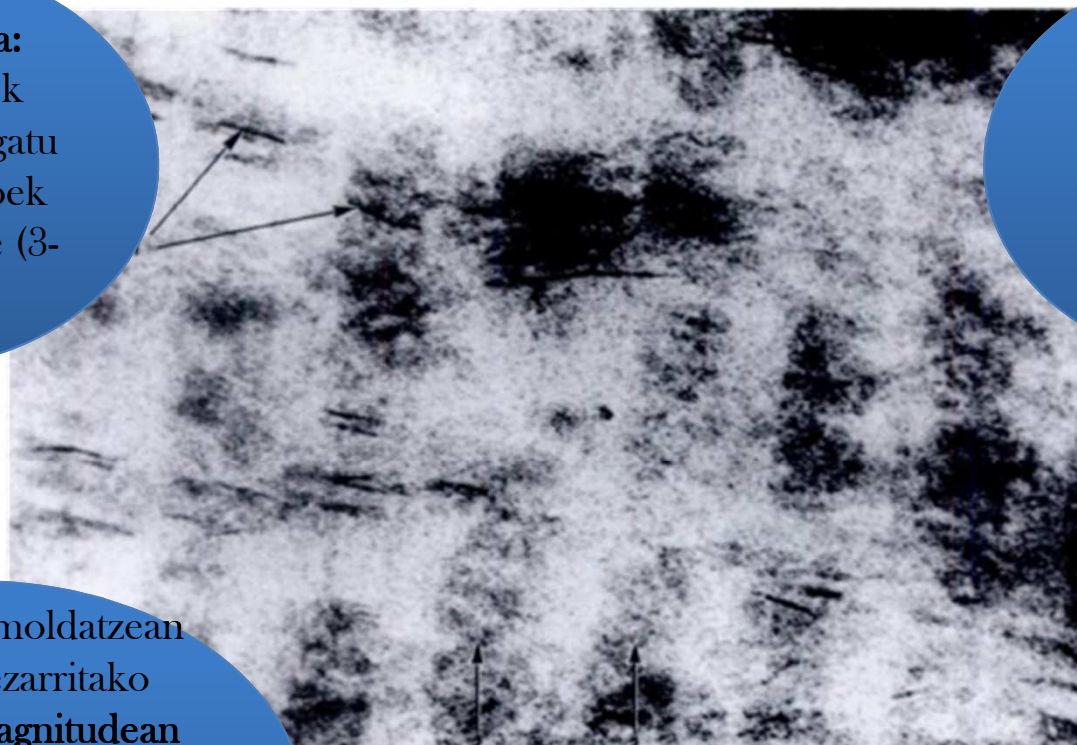


FIG. 13

age of mineralization. The deposition of mineral occurs in a highly ordered fashion with an axial
oms. Individual, plate-like crystals appear as dense lines when viewed on edge (1). Because the
they appear as less dense outlines (2). (Reprinted, with permission, from: Glimcher, M. J., and
of bone, and the mechanism of calcification. In Treatise on Collagen, edited by B. S. Gould. Vol. 2.

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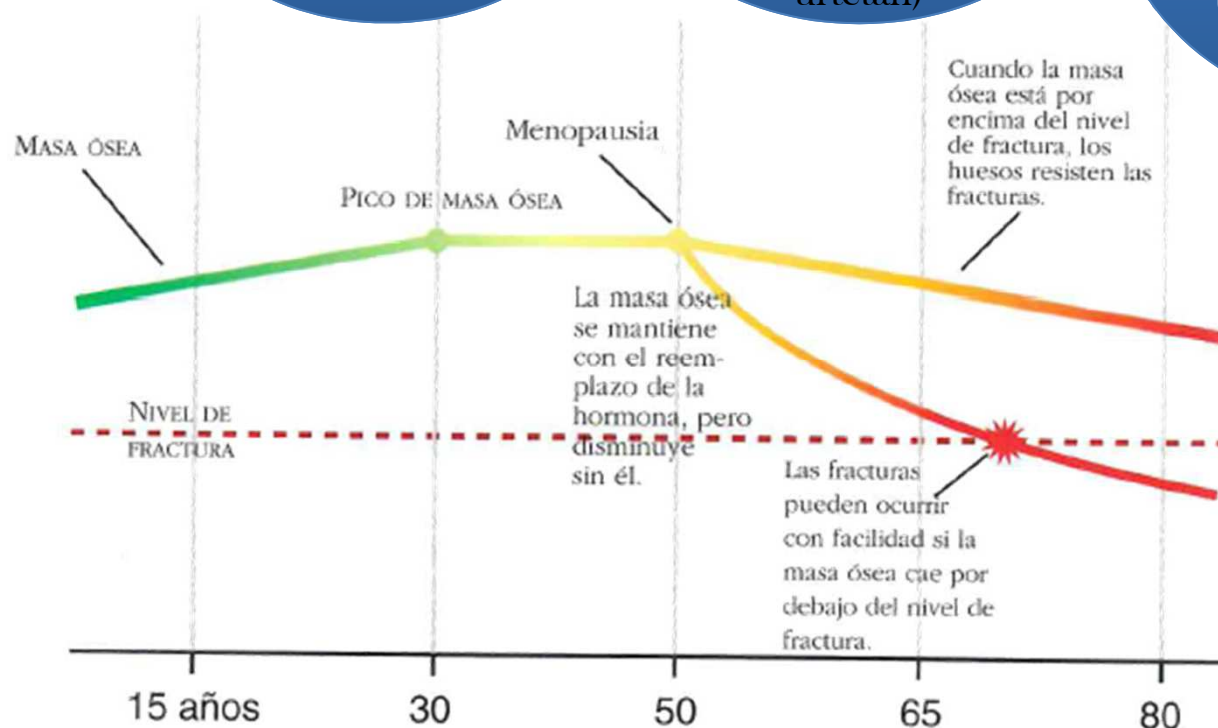
Bizitzan zeharreko hezur masaren zikloa

Haurtzaroa eta nerabezaroa:
Leiho terapeutikoa

35 urteetatik aurrera hezur kortikala galtzen hasten da urtean/%0.3-0.5

Menopausia:
Hezurra azkarrago galtzen da (~%3 batez beste 10 urtetan)

40-50 urteetatik aurrera hezurren bixurgatzea ↑
Emakumeak hezur kortikalaren %35 galtzen du eta hezur trabekularren %60 (gizonak %30 gutxi)



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Osteoporosia



Osteoporosia hezurren desoreka orokortua da, hezur masa murriztu eta hezurraren arkitektura narriatzeagatik ezaugarritzen dena.

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Osteoporosia

Definiciones de la OMS basadas en los niveles de densidad mineral ósea*

Normal

La DMO es +1 ó -1 DE de la media de los adultos jóvenes

Osteopenia (masa ósea baja)

DMO entre -1 y -2,5 DE por debajo de la media de adultos jóvenes

Osteoporosis

DMO es - 2,5 DE o más de la media de adultos jóvenes

Osteoporosis severa (establecida)

DMO mayor de - 2,5 DE y una o más fracturas por osteoporosis

*basado en la medición por DXA de cadera, columna o antebrazo

Nota Por cada desvío estándar (DE) inferior a la densidad mineral ósea máxima, el riesgo de fractura aumenta entre el 50 y el 100%. Los mismos valores de DMO se usan provisoriamente para los hombres, ya que en la actualidad hay pocos datos sobre DMO y fracturas en los hombres.

Bigarren
mailako
osteoporosia

Lehen
mailako
osteoporosia

Inboluziokoa
(>50 urte)

Ideopática
(<50 urte)

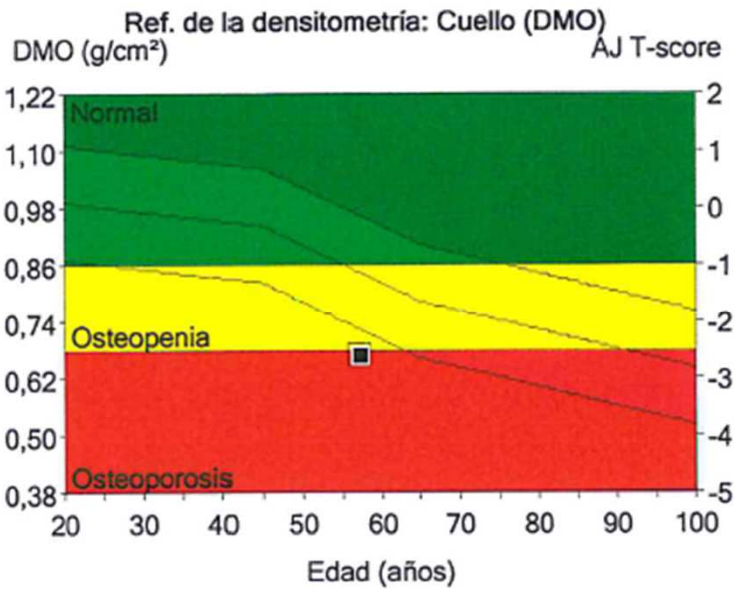
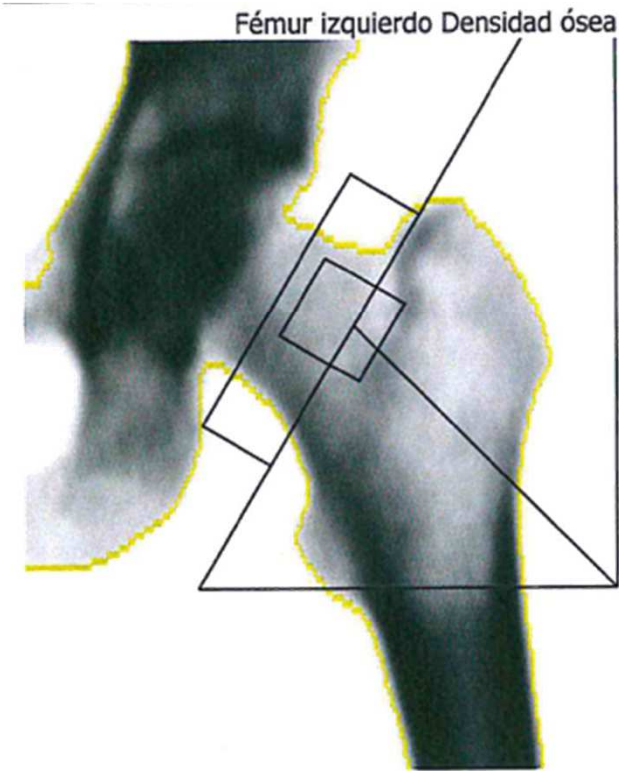
1. mola menopausia
ondorengoa
(Hipogonadismoa)

2. mola
Zahartzarokoa
(hormona
paratiroidea eta D
kita)

Growth factors
defektua

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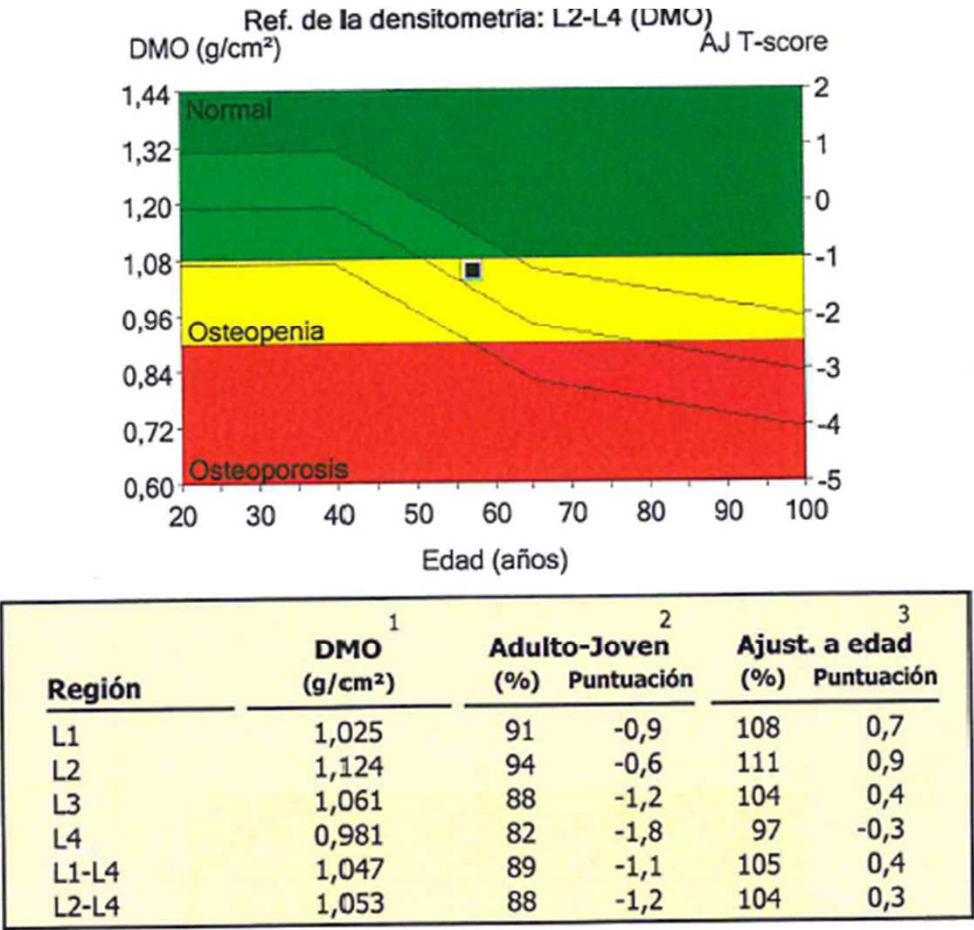
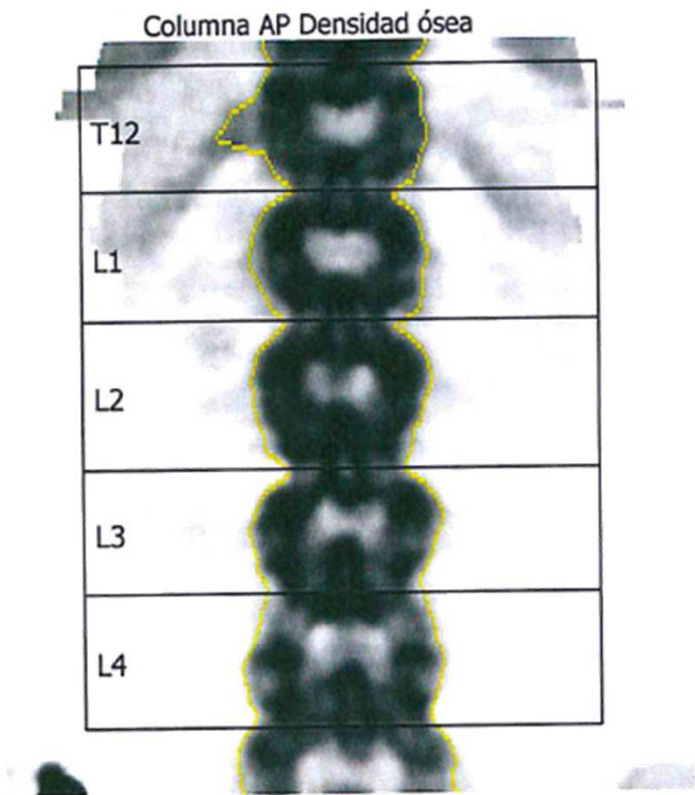
Osteoporosia neurtzea: DXA



Región	¹	²		³	
	DMO (g/cm²)	Adulto-Joven (%)	Puntuación	Ajust. a edad (%)	Puntuación
Cuello	0,666	68	-2,6	79	-1,5
Wards	0,560	61	-2,7	83	-0,9
Troc.	0,553	70	-2,2	78	-1,4
Diáfisis	0,850	-	-	-	-
Total	0,714	71	-2,4	80	-1,5

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Osteoporosia neurtzea: DXA



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Zergatik herrialdeen arteko desberdintasun hori?

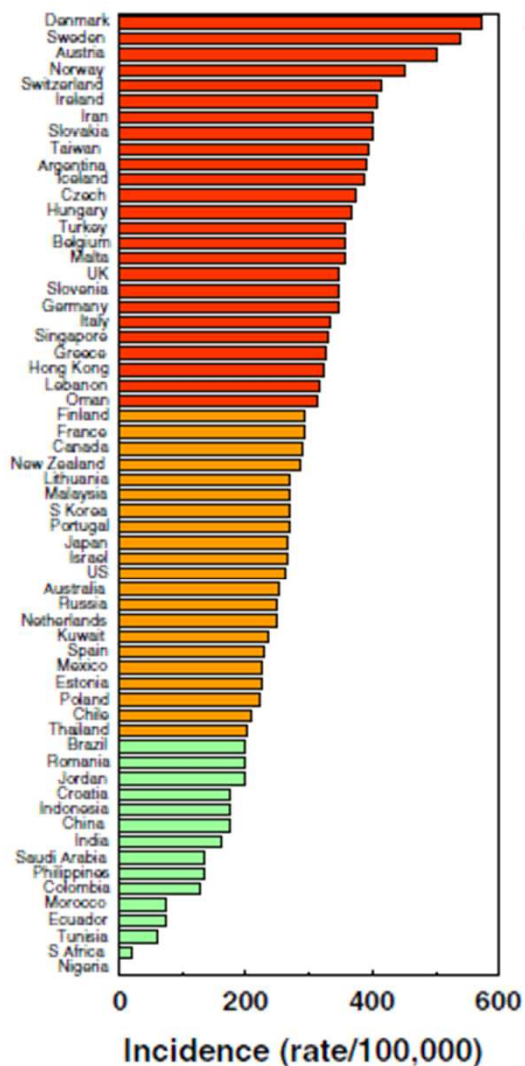


Fig. 1 Age-standardised annual incidence of hip fractures in women (/100,000) according to country together with the colour codes

Adinekoen %6.7ak (>65 urte) bizitzan zehar osteoporosi haustura bat pairatuko dutela aurreikusten da

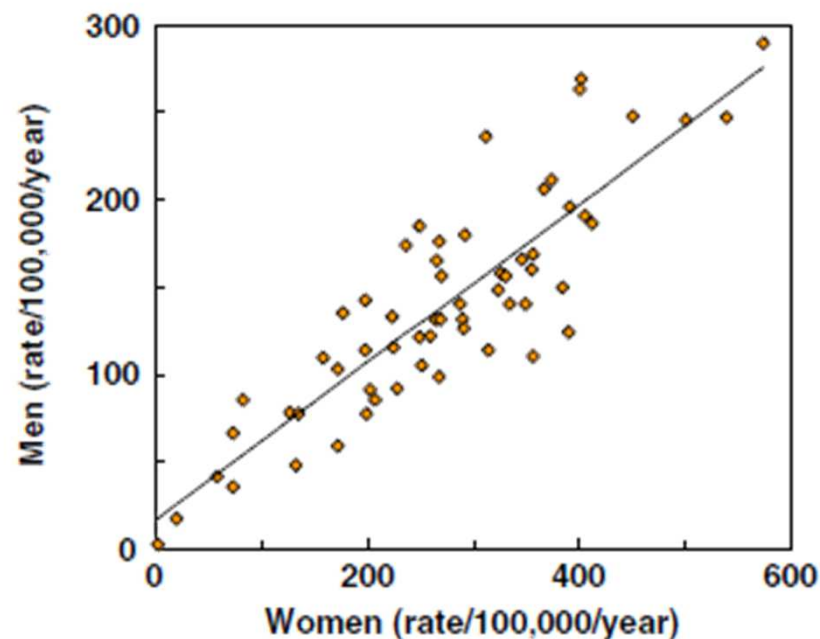


Fig. 2 World standardised hip fracture rates (/100,000/year) in men and women

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WOMEN OVER 50 WILL EXPERIENCE

ouch!
OSTEOPOROTIC FRACTURES. AS WILL





MEN

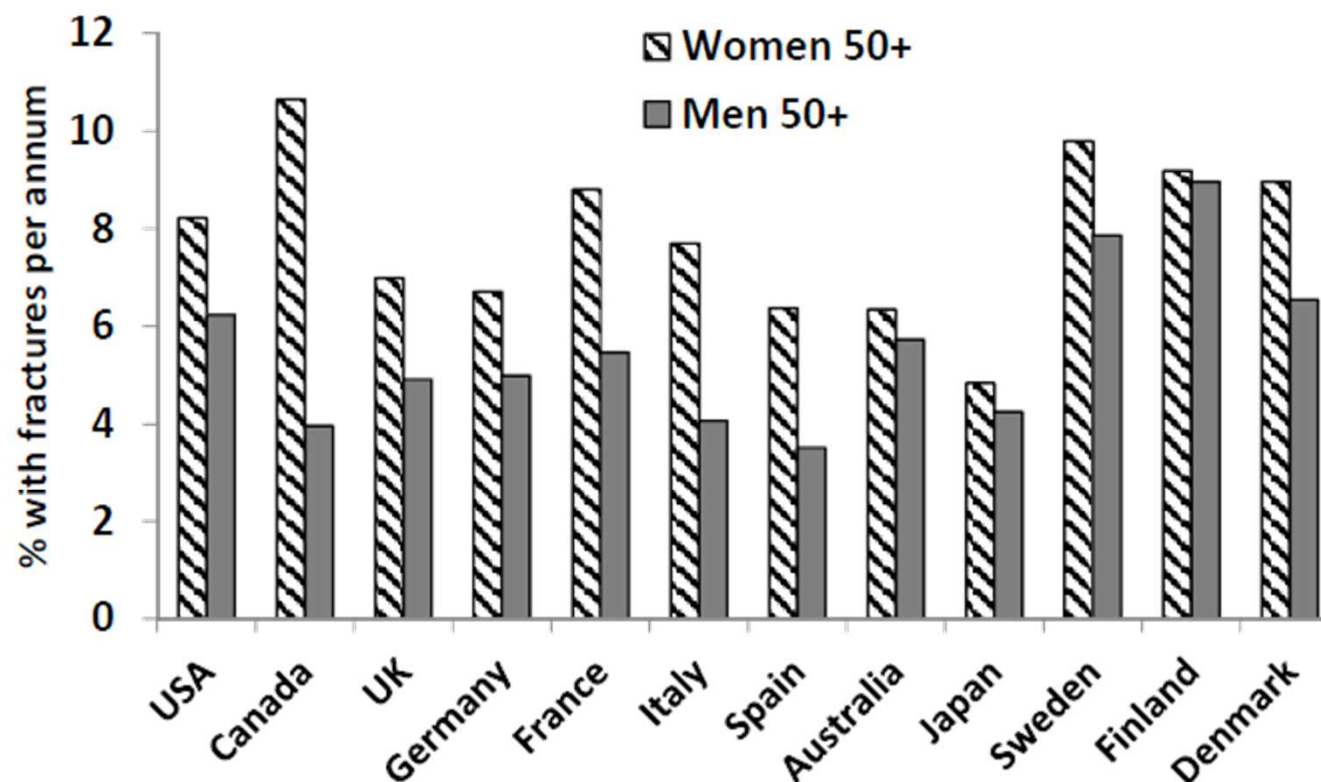


Figure 3. Non-traumatic fracture incidence (per 100 people) of hip, vertebral, and other bones for women versus men aged 50+ in select countries in 2010. Graph compiled from data published in Wade *et al.* [6].

Kruger & Wolber. *Nutrients* 2016; 8: 376-388

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Zergatik herrialdeen arteko desberdintasun hori?

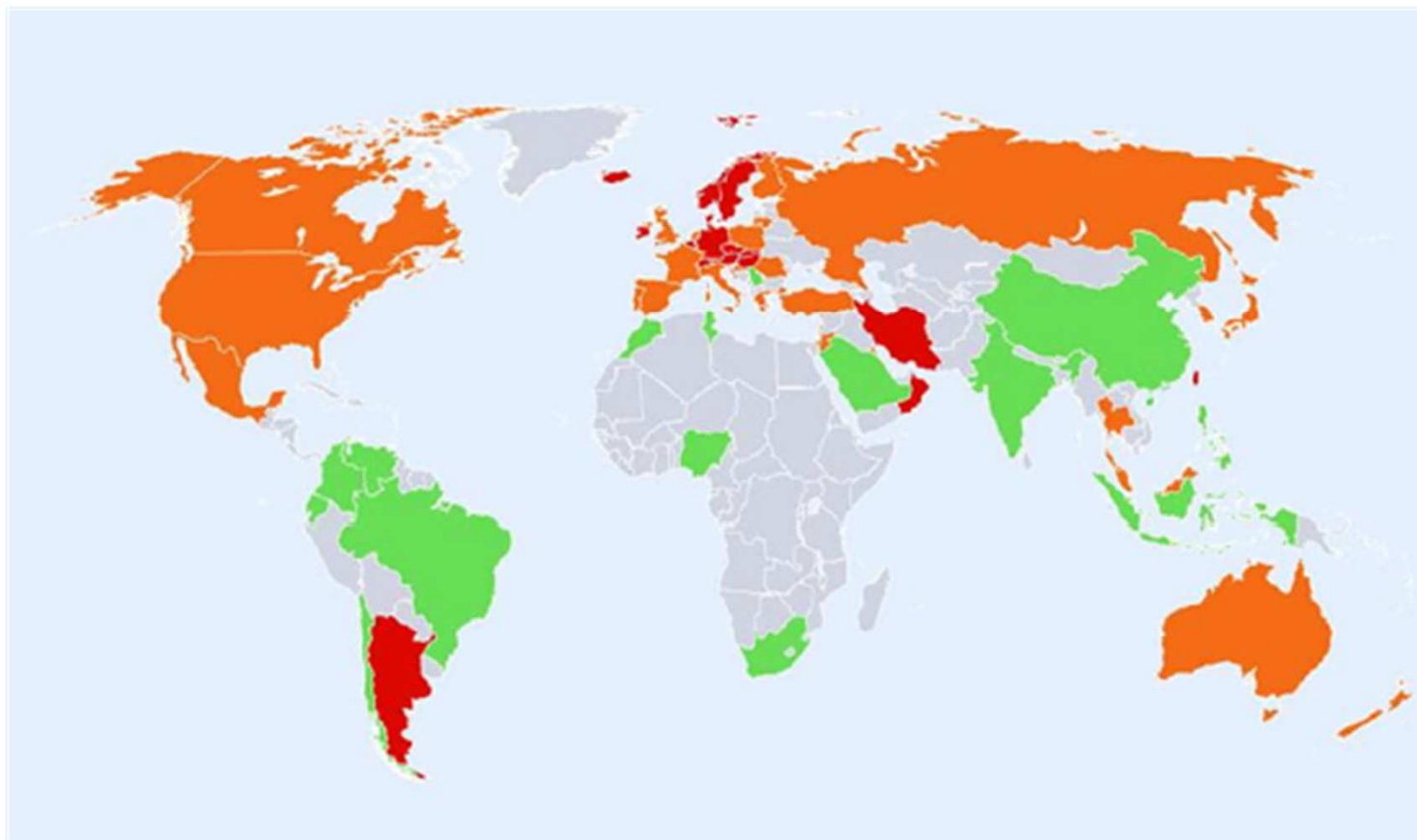
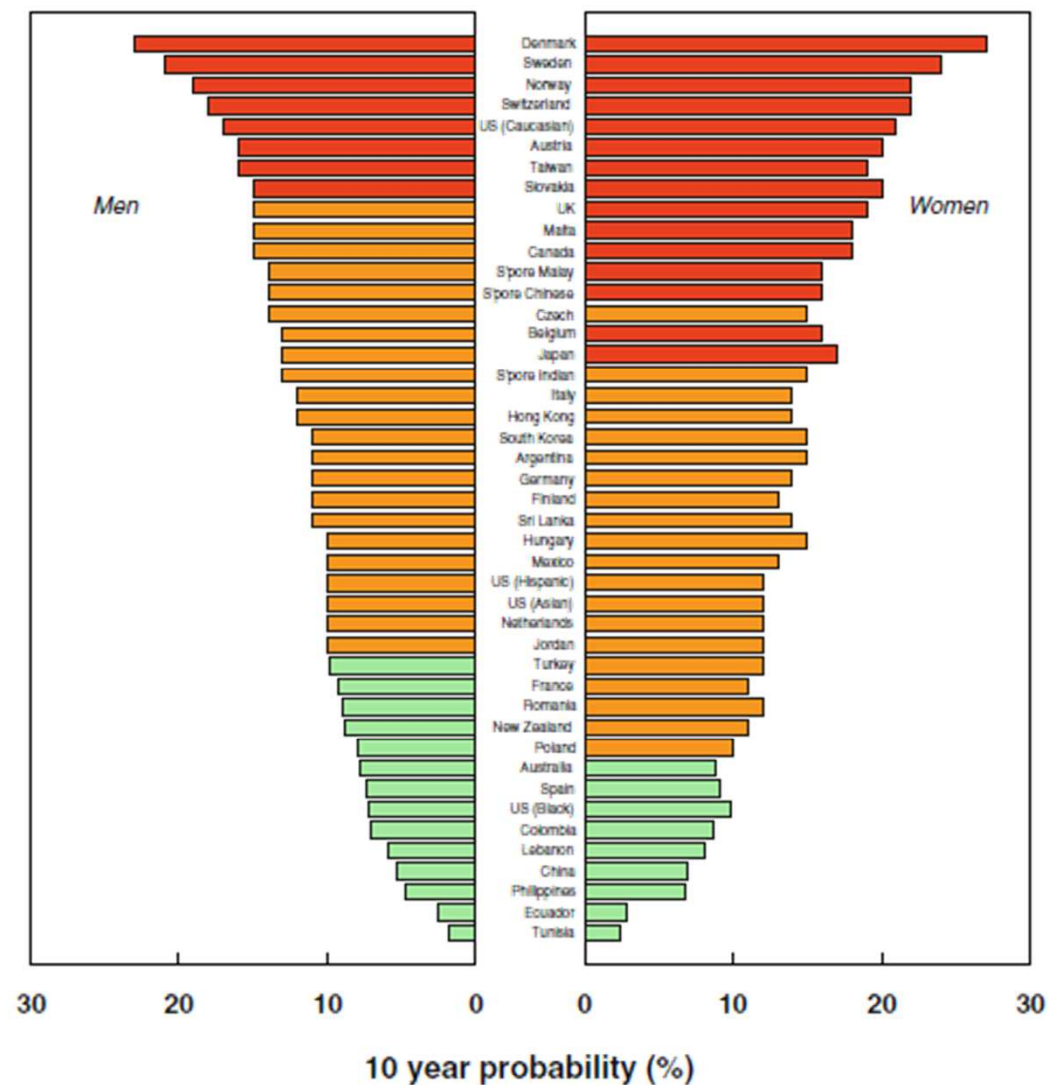


Fig. 5 Hip fracture rates for men and women combined in different countries of the world categorised by risk. Where estimates are available, countries are colour coded *red* (annual incidence $\geq 250/100,000$), *orange* (150–250/100,000) or *green* ($<150/100,000$)

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Fig. 6 Ten-year probability of a major fracture (in percent) in men and women aged 65 years with a prior fragility fracture (and no other clinical risk factors) at the threshold of osteoporosis as judged by BMD at the femoral neck (i.e. a T-score of -2.5 SD). The body mass index was set at 24 kg/m^2



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Genetic vs lifestyle



MÁS ADELANTE,
RIESGO DE
FRACTURA

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Table 1 Clinical risk factors used for opportunistic case finding [1]^a

Age
Sex
Low body mass index
Previous fragility fracture, particularly of the hip, wrist and spine including morphometric vertebral fracture
Parental history of hip fracture
Glucocorticoid treatment (>5 mg prednisolone daily for 3 months or more)
Current smoking
Alcohol intake, three or more units daily
Rheumatoid arthritis
Other secondary causes of osteoporosis
•Untreated hypogonadism in men and women, e.g., premature menopause, bilateral oophorectomy or orchidectomy, anorexia nervosa, chemotherapy for breast cancer, hypopituitarism
•Inflammatory bowel disease, e.g. Crohn's disease and ulcerative colitis. It should be noted that the risk is in part dependent on the use of glucocorticoids, but an independent risk remains after adjustment for glucocorticoid exposure.
•Prolonged immobility, e.g., spinal cord injury, Parkinson's disease, stroke, muscular dystrophy, ankylosing spondylitis
•Organ transplantation
•Type I diabetes
•Thyroid disorders, e.g., untreated hyperthyroidism, over-treated hypothyroidism
•Chronic obstructive pulmonary disease

^a With permission of the World Health Organization Collaborating Centre for Metabolic Bone Diseases, University of Sheffield Medical School, UK

Ten year probability of a major osteoporotic fracture (%)

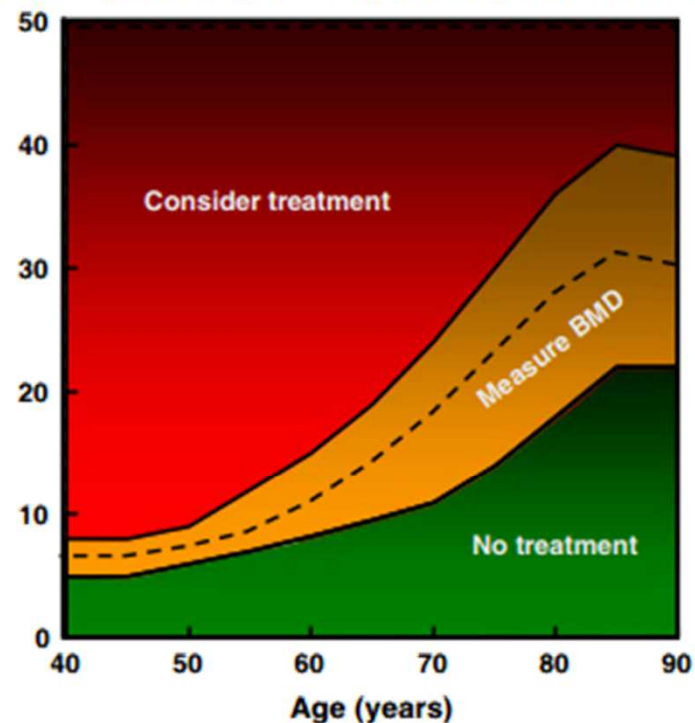


Fig. 3 Management chart for osteoporosis. The *dotted line* shows the intervention threshold, i.e., the probability at which intervention is recommended. The *orange shaded area* shows the limits of fracture probabilities for the assessment of BMD (BMD assessment thresholds). Reproduced with permission of the World Health Organization Collaborating Centre for Metabolic Bone Diseases, University of Sheffield Medical School, UK [09ca135]

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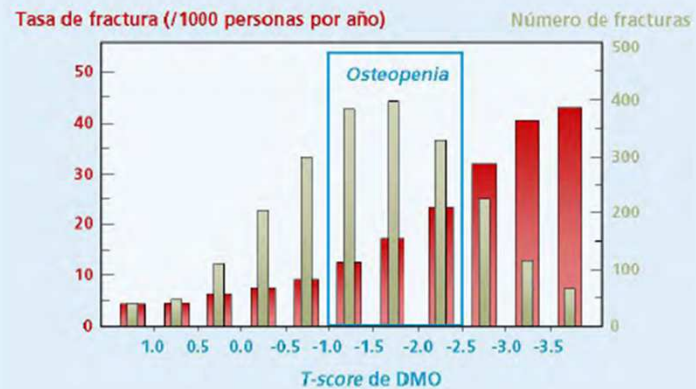
JF PROGRAMAREN

DISEINUA

FRAX galdetegia • <https://www.shef.ac.uk/FRAX/tool.jsp?lang=sp>

Figura 1

Fracturas por osteoporosis y Densidad Mineral Ósea (DMO)



La DMO es un fuerte predictor de riesgo de fractura. Sin embargo, la mayoría de las fracturas se producen en mujeres con DMO por encima del umbral de osteoporosis, generalmente, en el rango de la osteopenia (Siris et al, 2001).

país: Reino Unido Nombre/ID: Sobre los Factores de riesgo

Cuestionario:

1. Edad (entre 40-90 años) o fecha de nacimiento

Edad: Fecha de Nacimiento: A: M: D:

2. Sexo

☐ Hombre ☒ Mujer

3. Peso (kg)

4. Estatura (cm)

5. Fractura previa

☒ No ☐ Sí

6. Padres con Fractura de Cadera

☒ No ☐ Sí

7. Fumador Activo

☐ No ☒ Sí

8. Glucocorticoides

☐ No ☒ Sí

9. Artritis Reumatoide

☐ No ☒ Sí

10. Osteoporosis secundaria

☐ No ☒ Sí

11. Alcohol, 3 o más dosis por día

☒ No ☐ Sí

12. DMO de Cuello Femoral

T-Score

IMC: 15.2

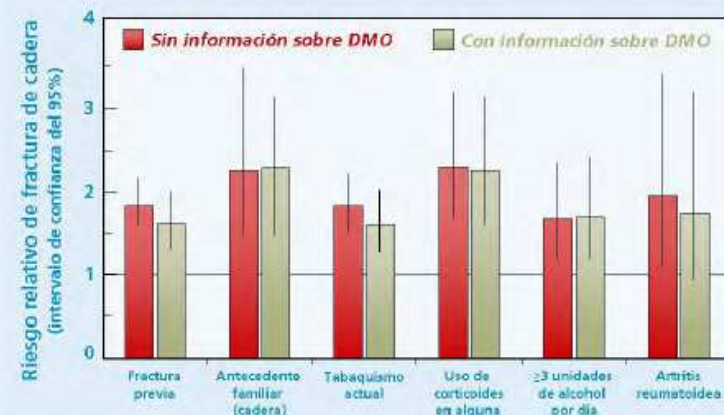
La probabilidad de diez años de fractura (%) con DMO

Mayor osteoporótica	5.5
La fractura de cadera	0.1

Si usted tiene un valor TBS, haga clic aquí:

Figura 2

FRAX® utiliza factores de riesgo independientes

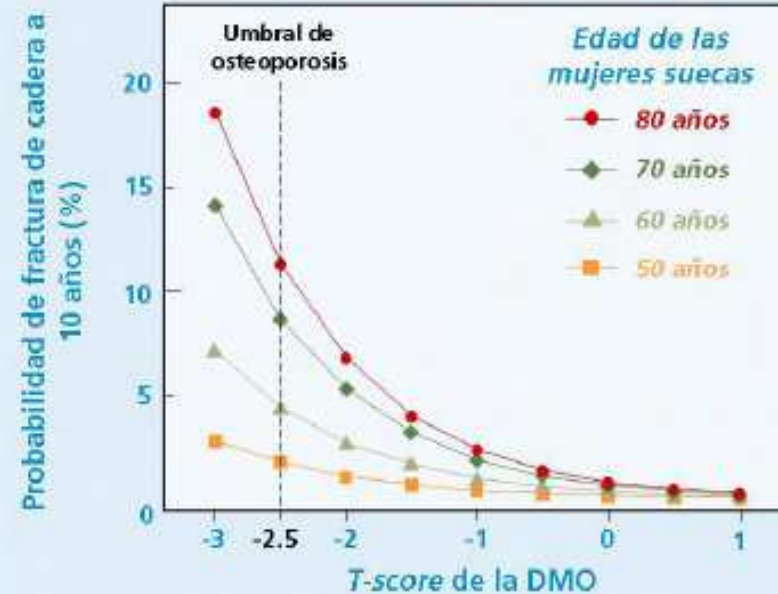
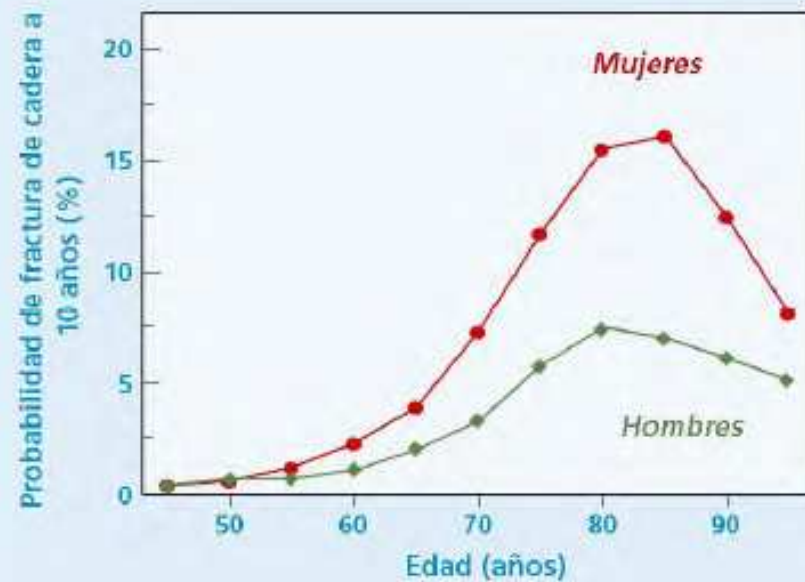


FRAX galdetegia • <https://www.shef.ac.uk/FRAX/tool.jsp>

Figura 4

La probabilidad de fractura está relacionada con la edad, la DMO y el género

En lugar de aplicar el mismo riesgo relativo para disminución de la DMO a todas las edades, FRAX® permite hacer un cálculo más individualizado que considera la DMO y su interacción con la edad.



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Nutrizioa eta osteoporosia

Dietary Reference Intakes: Macronutrients

Nutrient	Function	Life Stage Group	RDA/AI* g/d ^a	AMDR ^b	Selected Food Sources	Adverse effects of excessive consumption
Protein and amino acids	Serves as the major structural component of all cells in the body, and functions as enzymes, in membranes, as transport carriers, and as some hormones. During digestion and absorption dietary proteins are broken down to amino acids, which become the building blocks of these structural and functional compounds. Nine of the amino acids must be provided in the diet; these are termed indispensable amino acids. The body can make the other amino acids needed to synthesize specific structures from other amino acids.	Infants				While no defined intake level at which potential adverse effects of protein was identified, the upper end of AMDR based on complementing the AMDR for carbohydrate and fat for the various age groups. The lower end of the AMDR is set at approximately the RDA..
		0–6 mo	9.1*	ND ^c	Proteins from animal sources, such as meat, poultry, fish, eggs, milk, cheese, and yogurt, provide all nine	
		7–12 mo	11.0	ND	indispensable amino acids in adequate amounts, and for this reason are considered	
		Children			"complete proteins". Proteins from plants, legumes, grains, nuts, seeds, and vegetables tend to be deficient in one or more of the indispensable amino acids and are called	
		1–3 y	13	5-20	"incomplete proteins". Vegan diets adequate in total protein content can be "complete" by combining sources of incomplete proteins which lack different	
		4–8 y	19	10-30	indispensable amino acids.	
		Males				
		9–13 y	34	10-30		
		14–18 y	52	10-30		
		19–30 y	56	10-35		
		31–50 y	56	10-35		
		50–70 y	56	10-35		
		> 70 y	56	10-35		
		Females				
		9–13 y	34	10-30		
		14–18 y	46	10-30		
		19–30 y	46	10-35		
		31–50 y	46	10-35		
		50–70 y	46	10-35		
		> 70 y	46	10-35		
Pregnancy		≤ 18 y	71	10-35		
		19-30y	71	10-35		
		31-50 y	71	10-35		
		Lactation				
		≤ 18 y	71	10-35		
		19-30y	71	10-35		
		31-50 y	71	10-35		

~1g/kg
PRO
osteop
orosis



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Nutrizioa eta osteoporosia

**Tabla 1: PROPUESTA DE INGESTAS DIETÉTICAS DE REFERENCIA (IDR) PARA POBLACIÓN ESPAÑOLA.
FESNAD – 2010**

	Tiamin a mg	Ribofla vina mg	Niacin a mg	Ac. pantote nico µg ^a	Vit B ₆ mg	Biotina µg ^a	Ac. folico µg	Vit B ₁₂ µg	Vit C mg	Vit A µg	Vit D µg	Vit E mg ^a	Vit K µg ^a	Ca mg	P mg	K mg µg ^a	Mg mg ^a	Fe mg	Zn mg ¹⁹	I µg	Se µg ¹⁷	Cu mg µg ¹⁸	Cr µg ⁸	Na mg ⁶	Cl mg ⁶	F mg ⁶	Mn mg ⁶	Mo µg ⁶
Edad																												
0-6 meses	0,2	0,4	3	1,7	0,2	5	60	0,4	35	400	8,5	4,0	2,0	400 ¹⁵	300	650	40 ¹⁵	4,3	3,0	60	10	0,3	0,2	120	180	0,01	0,003	2,0
7-12 meses	0,3	0,4	5	1,8	0,4	6	50	0,5	35	350	10	5,0	2,5	525	400	700	75	8,0 ¹⁹	4,0	80	15	0,3	5,5	370	570	0,5	0,6	3,0
1-3 años	0,5	0,8	8	2,0	0,6	8	100	0,7	40	400	7,5	6,0	30	600	460	800	85	8,0 ¹⁹	4,0	80	20	0,4	11	1.000	1.500	0,7	1,2	17
4-5 años	0,7	0,9	11	3,0	0,9	12	150	1,1	45	400	5,0	7,0	55	700	500	1.100	120	8,0 ¹⁹	6,0	90	20	0,6	15	1.200	1.900	1,0	1,5	22
6-9 años	0,8	1,1	12	3,0 ⁷	1,0	12 ⁷	200	1,2	45	450	5,0	7,0 ⁷	55 ⁷	800	600	2.000	170	9,0 ¹⁹	6,5	120	25	0,7	15 ⁷	1.200 ⁷	1.900 ⁷	1,0 ⁷	1,5 ⁷	22 ⁷
Varones																												
10-13 años	1,0	1,3	15	4,0	1,2	20	250	1,8	50	600	5,0	11	60	1.100	900	3.100	280	12 ^{19,20}	8,0	135 ²⁰	35	1,0	25	1.500	2.300	2,0	1,9	34
14-19 años	1,2	1,5	15	5,0	1,4	25 ⁷	300	2,0	60 ¹²	800	5,0	15	75 ⁷	1.000	800	3.100	350	11 ^{19,20}	11	150 ²⁰	50	1,0	35	1.500	2.300	3,0 ⁷	2,2 ⁷	43 ⁷
20-29 años	1,2	1,6	18	5,0	1,5	30	300	2,0	60 ¹²	700	5,0	15	120	900	700	3.100	350	9,0 ¹⁹	9,5	150	55	1,1	35	1.500	2.300	4,0	2,3	45
30-39 años	1,2	1,6	18	5,0	1,5	30	300	2,0	60 ¹²	700	5,0	15	120	900	700	3.100	350	9,0 ¹⁹	9,5	150	55	1,1	35	1.500	2.300	4,0	2,3	45
40-49 años	1,2	1,6	18	5,0	1,5	30	300	2,0	60 ¹²	700	5,0	15	120	900	700	3.100	350	9,0 ¹⁹	9,5	150	55	1,1	35	1.500	2.300	4,0	2,3	45
50-59 años	1,2	1,6	17	5,0	1,5	30	300	2,0	60 ¹²	700	5,0	15	120	900	700	3.100	350	9,0 ¹⁹	9,5	150	55	1,1	30 ⁷	1.300 ⁷	2.000 ⁷	4,0	2,3	45
60-69 años	1,1	1,6	17	5,0	1,6	30	300	2,0	70 ¹²	700	7,5	15	120	1.000	700	3.100	350	10 ¹⁹	10	150	55	1,1	30	1.300	2.000	4,0	2,3	45
> 70 años	1,1	1,4	16	5,0	1,6	30	300	2,0	70 ¹²	700	10	15	120	1.000	700	3.100	350	10 ¹⁹	10	150	55	1,1	30	1.200	1.800	4,0	2,3	45
Mujeres																												
10-13 años	0,9	1,2	13	4,0	1,1	20	250	1,8	50	600	5,0	11	60	1.100	900	2.900	250	15 ^{19,20,21}	8,0	130 ²⁰	35	1,0	21	1.500	2.300	2,0	1,6	34
14-19 años	1,0	1,2	14	5,0	1,3	25 ⁷	300 ^{8,9}	2,0	60 ¹²	600	5,0	15	75 ⁷	1.000	800	3.100	300	15 ^{19,20,21}	8,0	150 ²⁰	45	1,0	24 ⁷	1.500	2.300	3,0	1,6 ⁷	43 ⁷
20-29 años	1,0	1,3	14	5,0	1,2	30	300 ^{8,9}	2,0	60 ¹²	600	5,0	15	90	900	700	3.100	300	18 ¹⁹	7,0	150	55	1,1	25	1.500	2.300	3,0	1,8	45
30-39 años	1,0	1,3	14	5,0	1,2	30	300 ^{8,9}	2,0	60 ¹²	600	5,0	15	90	900	700	3.100	300	18 ¹⁹	7,0	150	55	1,1	25	1.500	2.300	3,0	1,8	45
40-49 años	1,0	1,3	14	5,0	1,2	30	300 ^{8,9}	2,0	60 ¹²	600	5,0	15	90	900	700	3.100	300	18 ¹⁹	7,0	150	55	1,1	25	1.500	2.300	3,0	1,8	45
50-59 años	1,0	1,3	14	5,0	1,2	30	300	2,0	60 ¹²	600	5,0	15	90	1.000	700	3.100	300	15 ¹⁹	7,0	150	55	1,1	20 ⁷	1.300 ⁷	2.000 ⁷	3,0	1,8	45
60-69 años	1,0	1,2	14	5,0	1,2	30	300	2,0	70 ¹²	600	7,5	15	90	1.000 ¹⁸	700 ¹⁸	3.100	320 ¹⁸	10 ^{19,19}	7,0	150	55	1,1	20	1.300	2.000	3,0	1,8	45
> 70 años	1,0	1,2	14	5,0	1,2	30	300	2,0	70 ¹²	600	10	15	90	1.000	700	3.100	320	10 ¹⁹	7,0	150	55	1,1	20	1.200	1.800	3,0	1,8	45
Embarazo	1,2 ^{1,3,3,8}	1,6 ^{1,3,8}	15 ^{1,3,8}	6,0	1,5 ^{1,3,8}	30	500 ^{8,9,11}	2,2 ^{1,4}	80 ^{1,4}	700 ^{1,3,8,11}	10 ^{1,4}	15	90	1.000 ^{1,4,11}	800 ^{1,3,11}	3.100 ^{1,4}	360 ^{1,11}	25 ^{1,4,11}	10 ^{1,3,4,11}	175 ^{1,4,11}	55 ^{1,4,11}	1,1 ^{4,11}	30	1.500	2.300	3,0	2,0	50
Lactancia	1,4 ¹	1,7 ¹	16 ¹	7,0	1,6 ¹	35	400 ⁵	2,6 ^{5,11}	100 ⁵	950 ^{1,14}	10 ¹	19	90	1.200 ⁵	990 ⁵	3.100 ⁵	360	15 ^{5,19}	12 ⁵	200 ⁵	70 ⁵	1,4 ⁵	45	1.500	2.300	3,0	2,6	50

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Nutrizioa eta c

TABLA 2. CONTENIDO APROXIMADO EN CALCIO DE ALGUNOS ALIMENTOS

Alimento	Mg por 100 g de porción comestible
Chanquetes y morralla (pescaditos enteros)	2250
Queso Emmental	1080
Queso magro	1050
Queso Gruyère	900
Queso Manchego curado	848
Queso Roquefort	600
Queso en porciones	276
Anchoas en aceite	273
Higos secos	250
Soja seca	240
Leche de almendras	200
Soja fresca	197
Crajañá	193
Frutos secos (excepto castaña)	190-270
Queso de Burgos	186
Chocolate con leche	188
Helados	150
Gambas y camarones	150
Yogur natural	121
Leche	120
Peut suisse	120
Espinacas	104
Legumbres	70-140
Acelga, cardo	80

Tomado de Matute J. Mañas M. Tabla de composición de alimentos españoles (4ª ed.). Universidad de Granada: Instituto de Nutrición y Tecnología de Alimentos, 2003.

TABLA 3. FACTORES QUE INFLUYEN EN LA BIODISPONIBILIDAD DEL CALCIO

AUMENTAN LA ABSORCIÓN

- Crecimiento, embarazo, lactancia (aumento de las necesidades)
- Déficit de calcio
- Vitamina D
- Ingesta de grasas
- Ingesta de lactosa
- Aminoácidos acidicos de la dieta
- pH intestinal

DISMINUYEN LA ABSORCIÓN

- Déficit de vitamina D
- Ácidos grasos libres de la dieta
- Exceso de fibra en la dieta (más de 30g/día)
- Oxalatos (espinacas, acelgas, fresas...)
- Fitatos (cereales integrales, de grano entero, legumbres)
- Exceso de proteínas y fósforo
- Cafeína (más de 3 tazas de café/día)
- pH intestinal alto
- Gastritis atrófica asociada a la falta de producción de ácido clorhídrico en el anciano
- Edad avanzada (por falta de síntesis de vitamina D y aparición de gastritis atrófica)

Yogures/quesos

Leche

Espinacas/Acelgas



Absorción: 20-45%

Absorción: 27%

Absorción: 5%

Alfonso. Univ.Navarra 2005; 77: 1256-1275

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DASH dietak hezur erresortzioa murrizten du. Na (1) : K (1)

Table 1
Intakes of Nutrients Important for Bone Health According to Serving Sizes of Foods of the DASH Diet

Food groups (examples of a serving)	DASH diet (minimum servings/day)	Approximate calcium intake (foods fortified), mg	Approximate sodium intake, mg	Approximate potassium intake, mg	Approximate protein intake, g
Milk products					
Milk, 1% (250 mL, 1 cup)	2	575	720	520	17
Cheese (50 g)					
Grain products					
Bread (1 slice)	7	160	950	560	21
Cereal (30 g, 1 cup)					
Rice (1 cup)					
Vegetable group (raw leafy vegetable)					
Lettuce (1 cup)	4	200	100	970	6
Spinach (1 cup)					
Fruit group					
Banana (medium size)	4	95	10	1610	4
Orange (medium size)					
Orange juice (1/2 cup)					
Meat					
Lean meat (80 g)	2 or less	50	135	550	19
Fish (80 g)					
Poultry (80 g)					
Alternatives					
Egg (1)	0.6 (4 servings/week from nuts, seeds, and dry beans)	30	35	180	8
Cooked dry beans (125 g)					
Tofu (100 g)					
Peanut butter (2 tbsp-30 mL)					
Total	—	1110	1950*	4390	75

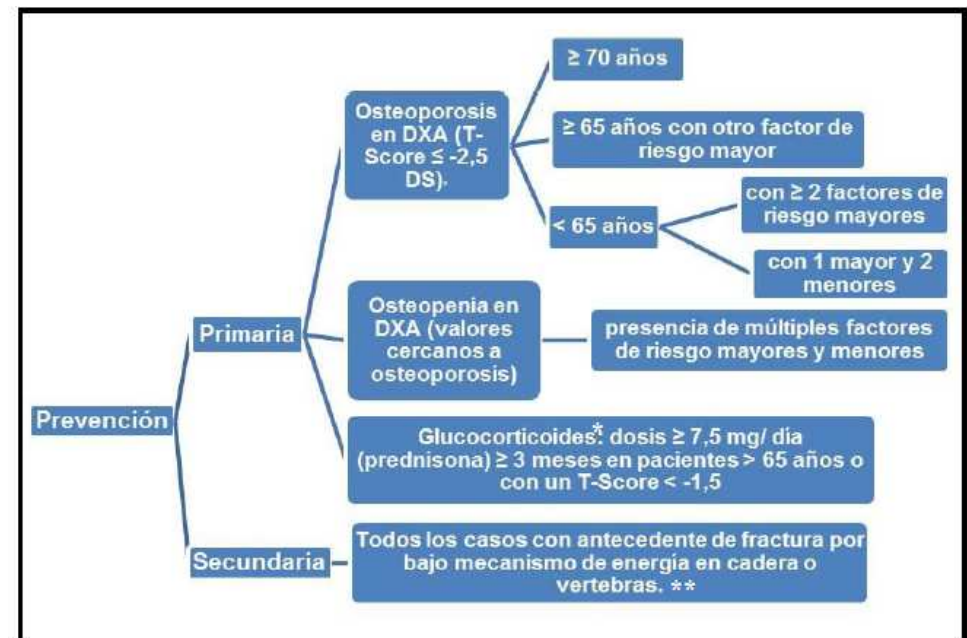
Note: Calcium, potassium, and protein are close to, or exceed, current recommendations, whereas sodium intake falls below its upper level.
Modified from Institute of Medicine (1).

Abbr: DASH, Dietary Approaches to Stop Hypertension.

*Consuming unsalted products reduces sodium intake further.

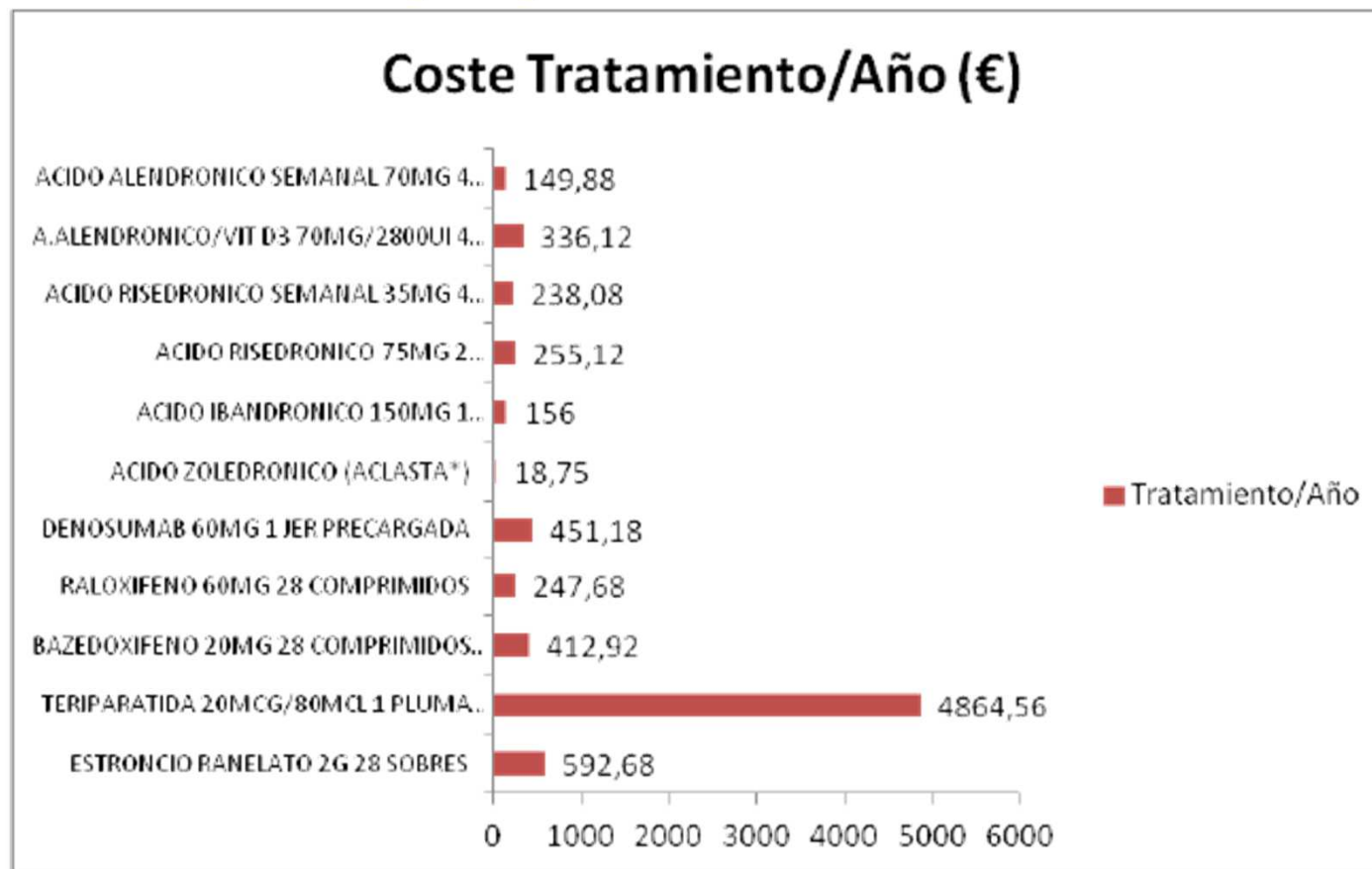
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Helburua hausturak ekiditea • aldaka haustura duen 5 pertsonetatik 1ek urtebete baino gutxiago bizi da hautsi ondoren



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Helburua hausturak ekiditea • aldaka haustura duen 5 pertsonetatik 1ek urtebete baino gutxiago bizi da hautsi ondoren



Los cálculos corresponden a los precios PVP IVA (€) del mes de diciembre (2014).

*PVL/uso hospitalario.

Osteoporosiari haurtzarotik aurre egin behar zaio

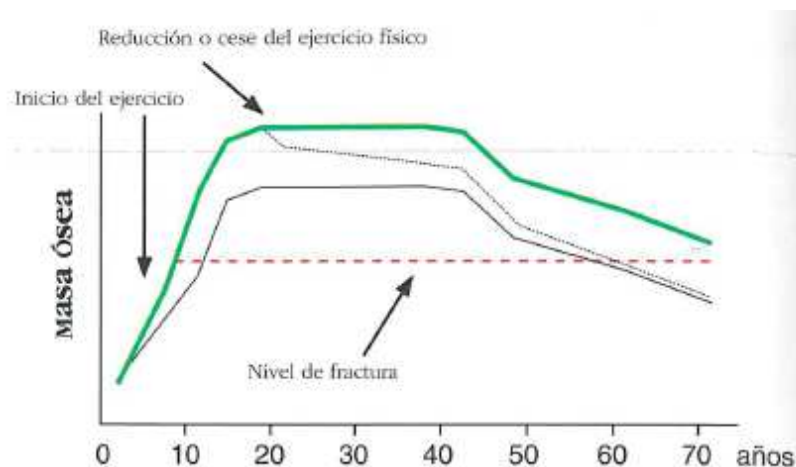


Figura 1. Cambios teóricos en la masa ósea con la edad si hay: 1) no práctica de ejercicio físico durante el crecimiento (-), 2) participación regular en una actividad física durante el crecimiento y los incrementos de masa ósea se mantienen a lo largo de la edad adulta, a pesar de la reducción o cese del ejercicio físico (—), y 3) participación regular en una actividad física durante el crecimiento, pero las ganancias de masa ósea se pierden gradualmente durante la edad adulta si el nivel de ejercicio se reduce o cesa (—) (Modlesky y Lewis, 2002).

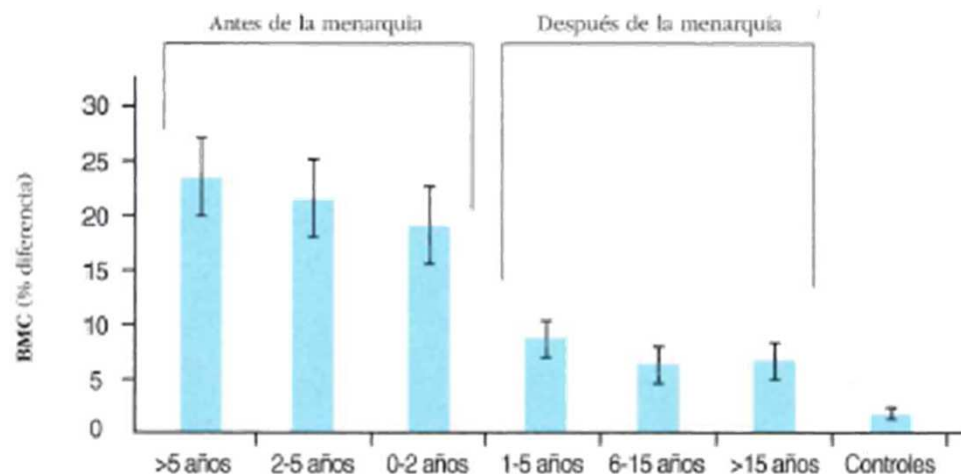
Why exercise is vital for bone and muscle health:

- It **builds strong bones** in youth. It's estimated a 10 per cent increase of peak bone mass in children can reduce the risk of an osteoporotic fracture during adult life by 50 per cent.
- Exercise plays a key role in adults **preventing bone loss and maintaining muscle strength**.
- It helps **prevent weak bones and falls in the elderly**. One-third of people over 65 have a fall each year and the risk of falling increases as age rises.
- People who have **suffered fractures can benefit from special exercises and training** (under medical supervision) to improve muscle strength and muscle function for greater mobility and improved quality of life.



**Haurtzaroa eta
nerabezaroa:
Hezur masa
pikoa handitzeko
leiho terapeutikoa**

Osteoporosiari haurtzarotik aurre egin behar zaio



2 irudia BMCn aldea menarkia aurretik eta ondoren entrenatzen hasi ziren tenis jokalarietan beso nagusiaren eta ez nagusiaren artean (Kannus et al., 1995).

Karga mekanikoak **estrogeno hartzailleak** barne hartzen dituen gertakari zelular ugari isurtzen ditu. Horregatik, osteogenia efektua handiagoa da E_{α} -k altuak direnean (nerabezaroa, menopausia aurretik vs. amenorrea, menopausia ondoren, obariotomia)

Eskeletoak EFari
sentsibiltate
handiagoa dio
nerabezaroaren
lehenengo urteetan:
GH, IGF-1,
androstendiona eta
estradiola



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Osteoporosiari haurtzarotik aurre egin behar zaio



High strain-
eliciting
sports
(gimnasia)

Weight-bearing
and contact
activities
(football, rugby,
handball)

Haurtzaroan eta nerabezaroan **kiroletan parte hartzeak** (pubertaro aurretik) hezur masa pilatzen laguntzen du (BMC & aldaketa geometrikoak), helduaroan hezur indartsuagoak sortuz

%10 **gehiago** sedentarioekin alderatuta DMO osoan, %15-20ko baloreekin kirola praktikatzean karga handiagoak jasaten dituzten zonaldeetan (**espezifikotasuna**), %13-17 DMO gehiago gerrialdeko arantzan, %20-25 aldakan eta %10-16 beheko gorputz adarretan

High ground
reaction forces
(gravity) (jumping,
sprinting, rapidly
changing direcytion,
stopping, fall
landings, blocks)

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Osteoporosiari haurtzarotik aurre egin behar zaio



Egunean 500m
korrika egitea
10km/orduan
nahikoa da
BMDa
hobetzeko

Aktiboen diren haurrak (AP guztia eta gihartsua)
sedentarioak baino BMC %12 gehiago zuten. **Egunean
10min handitzea jarduera gihartsua** ↑%2-3 BMC
aldakan eta gerrialdean

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Inpaktu falta eta inpaktu gehiegi kaltegarriak



Distantzia luzeko
korrikalarietan
entrenamendu
bolumen gehiegi (19-
56 urte) (>100km/s)
↓20% BMD
gerrialdeko arantzan

Hilekoaren zikloaren
aldaketak eliteko atleten
%50, atleta amateurren
%25 eta igerilarien eta
txirrindularien %12
kaltetu dezake

Igerilari,
txirrindulari eta
arraunlarien
BMDa
sedentarioen
antzekoa

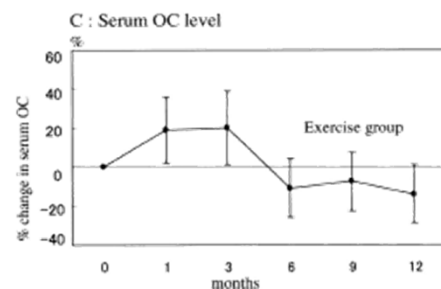
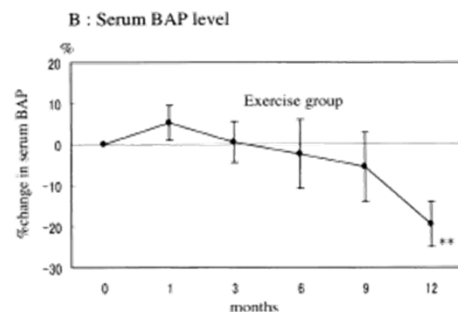
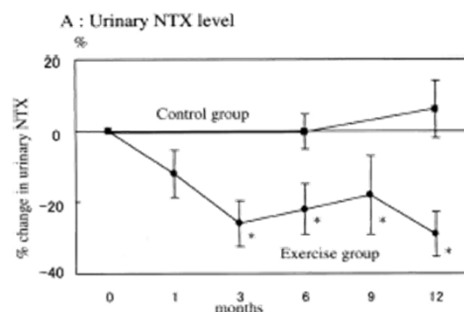
Jarduera fisikoa helduaroan eta menopausian **Ibiltzearekin nahikoa da?**

Table 2. Daily step count and heart rate

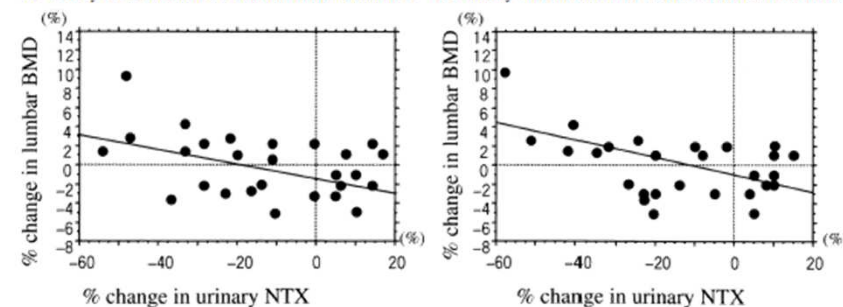
	Exercise (n = 27)	Control (n = 15)
Heart rate (beats/min)		
Baseline (THR)	108 ± 7.5	ND
Month 6	107 ± 6.3	ND
Month 12	102 ± 5.6*	ND
Walking speed at baseline (km/h)	4.2 ± 0.4	ND
Daily step count (steps/day)		
Baseline	4256 ± 348	4025 ± 315
Month 6	8053 ± 352**	ND
Month 12	8185 ± 315**	ND
Frequency of exercise (days/week)	4.2 ± 0.3	ND

Table 3. Change in lumbar BMD

	Baseline	Month 6	Month 12
Exercise (n = 27)			
Lumbar BMD (g/cm ²)	0.699 ± 0.08	0.703 ± 0.09	0.714 ± 0.09
Percent change from baseline (%)		0.47 ± 0.21	1.71 ± 0.85*
Control (n = 15)			
Lumbar BMD (g/cm ²)	0.728 ± 0.07	0.724 ± 0.07	0.712 ± 0.08
Percent change from baseline (%)		-0.45 ± 0.31	-1.92 ± 0.76



A : Urinary NTX at month 3 vs. lumbar BMD at month 12 B : Urinary NTX at month 12 vs. lumbar BMD at month 12



Astean >4h ibiltzeak gerrialdeko

DMOa hobetzen du

osteopenia/osteoporosia duten PM

emakumeetan, hezurren erresortzioa

ejabatuz

Hautsurren arriskua ↓41%

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Jarduera fisikoa helduaroan eta menopausian **ibiltzearekin nahikoa da?**

Meta-analysis of walking for preservation of bone mineral density in postmenopausal women

Marrissa Martyn-St James ^{a,*}, Sean Carroll ^b

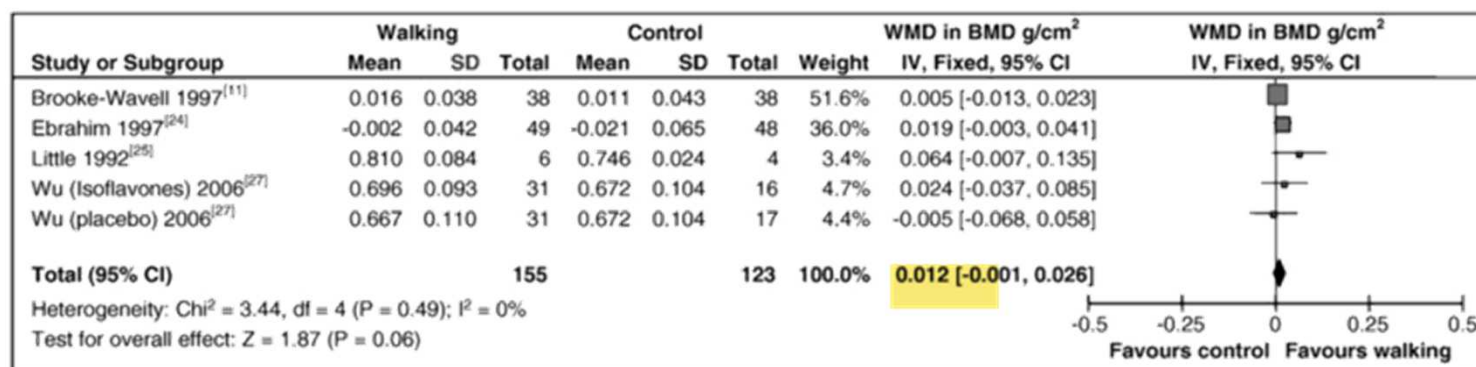
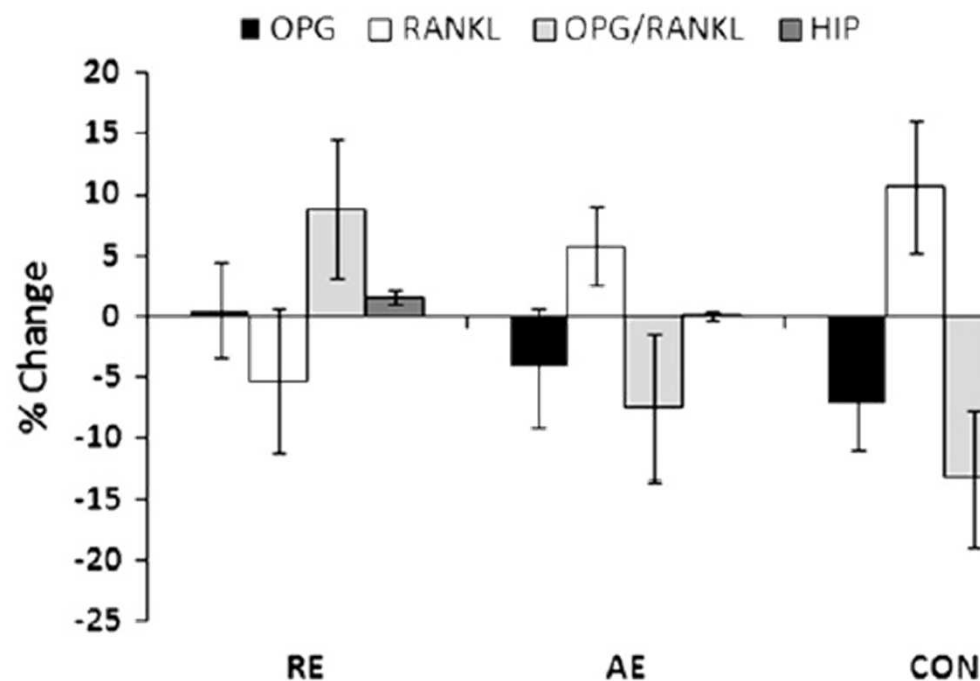


Fig. 3. Forest plot for RCT effects of walking on femoral neck bone mineral density.

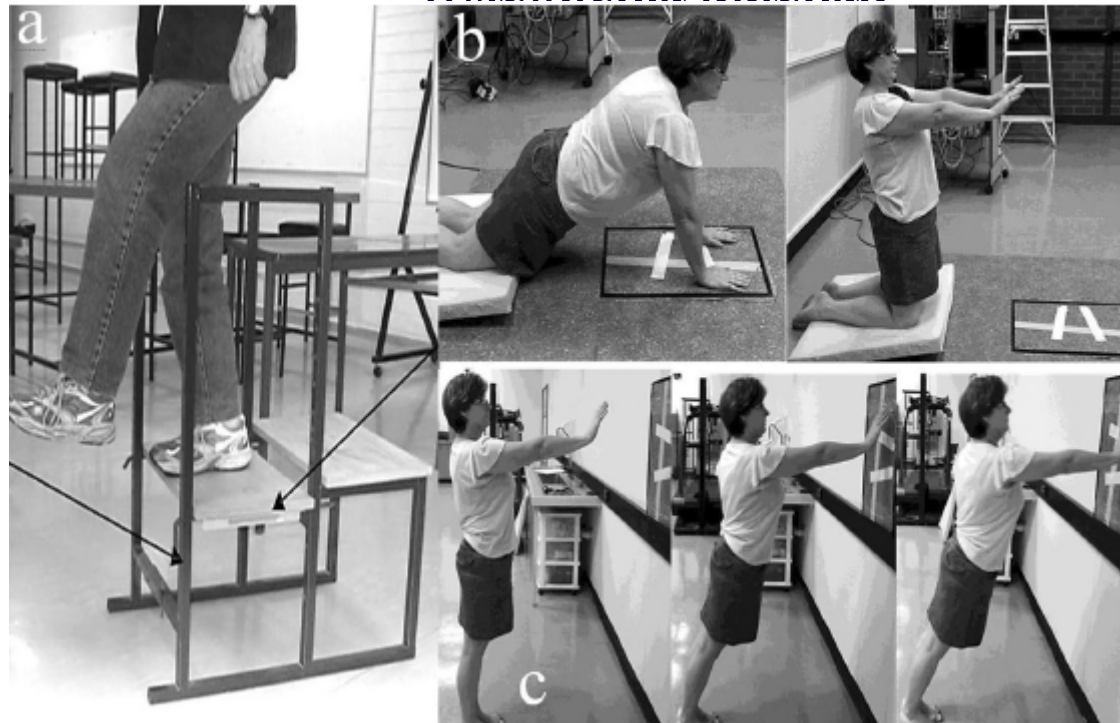
Jarduera fisiko bakarra ibiltzea izatea **ez da nahikoa** PM emakumeetan gerrialdeko DMO galeraren prebentziorako (Guadalupe Brau et al., 2009; Heikkinen et al., 2007; Martyn-St James & Carrol, 2008)

Indarraren entrenamendua



- REa (3d/s - 8hilabete) BMDa igo zuen bakarra izan zen (%2.9 trokanterrean eta %1.5 aldakan orokorrean) adineko emakumeetan (70 urte)
- REak hezurren suntsiketa eragozten du ($\downarrow$ RANKL y $\uparrow$ OPG) (Marques et al., 2011)

High-Intensity Impact Training • Menopausia aurreko emakumeak, Osteopenia dutenak



a	Blocks of 8 Weeks	Step Level (cm)	Sessions	Sets and repetitions for each foot or hand for consecutive weeks in a block								Total Impacts/Week/Foot or Hand
				1	2	3	4	5	6	7	8	
				2x3	2x4	2x5	3x4	3x5	3x6	2x10	3x8	
	1-8	1 (18.5)	4	2x3	2x4	2x5	3x4	3x5	3x6	2x10	3x8	452
	9-16	2 (28.5)	4	3x9	4x7	3x10	4x8	3x11	4x9	3x12	4x10	1,048
	17-24	3 (36.0)	4	4x8	4x9	4x10	5x8	4x10	5x8	4x10	5x8	1,232
	25-32	4 (43.5)	4	4x8	4x9	4x10	5x8	4x10	5x8	4x10	5x8	1,232
	33-40	5 (48.5)	4	4x8	4x9	4x10	5x8	4x10	5x8	4x10	5x8	1,232
	41-48	6 (53.5)	4	4x8	4x9	4x10	5x8	4x10	5x8	4x10	5x8	1,232
	49-56	7 (58.5)	4	4x8	4x9	4x10	5x8	4x10	5x8	4x10	5x8	1,232
	57-64	8 (63.5)	4	4x8	4x9	4x10	5x8	4x10	5x8	4x10	5x8	1,232

High-Intensity Impact Training • Menopausia aurreko emakumeak, Osteopenia dutenak

Table 1 Baseline characteristics and comparisons within and between groups for exercisers and controls with below average forearm aBMD

Forearm Variable	Exercise group				Control group				MANOVA	
	Baseline ± SD	Post ± SD	% Change	Cohen's d	Baseline ± SD	Post ± SD	% Change	Cohen's d	p value	η ²
UD radius BMD	0.317 ± 0.021	0.329 ± 0.022	3.9***	1.281	0.322 ± 0.024	0.309 ± 0.028	-3.9***	1.018	0.000	0.771
UD radius Z	-1.63 ± 0.57	-1.28 ± 0.59	21.6***	1.308	-1.50 ± 0.65	-1.83 ± 0.77	-22.3***	1.019	0.000	0.778
UD radius T	-1.63 ± 0.57	-1.30 ± 0.60	20.4***	1.258	-1.51 ± 0.65	-1.86 ± 0.77	-23.1***	1.006	0.000	0.769
Total body BMD	1.169 ± 0.055	1.174 ± 0.057	0.4	0.295	1.157 ± 0.046	1.139 ± 0.044	-1.6**	0.798	0.000	0.454
Total body BMC (g)	2467 ± 318	2467 ± 307	0.0	0.003	2413 ± 233	2380 ± 247	-1.4*	0.524	0.099	0.119
Total lean (g)	43679 ± 6269	43240 ± 6208	-1.0	0.392	41409 ± 4009	41566 ± 4253	0.4	0.182	0.036	0.184
Height (m)	1.658 ± 0.078				1.657 ± 0.069					
Weight (kg)	71.58 ± 20.2	71.66 ± 19.80	0.1	-0.004	65.08 ± 11.56	65.23 ± 12.02	0.2	0.052	0.945	0.000
BMI	25.9 ± 6.2	25.9 ± 6.3	0.2	-0.009	23.7 ± 3.8	23.7 ± 3.9	0	0.027	0.933	0.000
Calcium (mg/day)	717 ± 565	1102.4 ± 86	54*	0.496	589 ± 491	821 ± 481	39	0.306	0.082	
Age (years)	42.6 ± 8.3				42.7 ± 8.4					

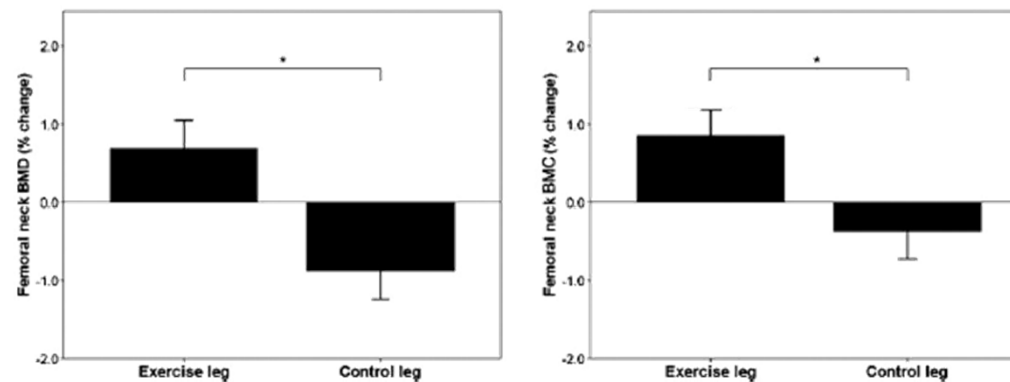
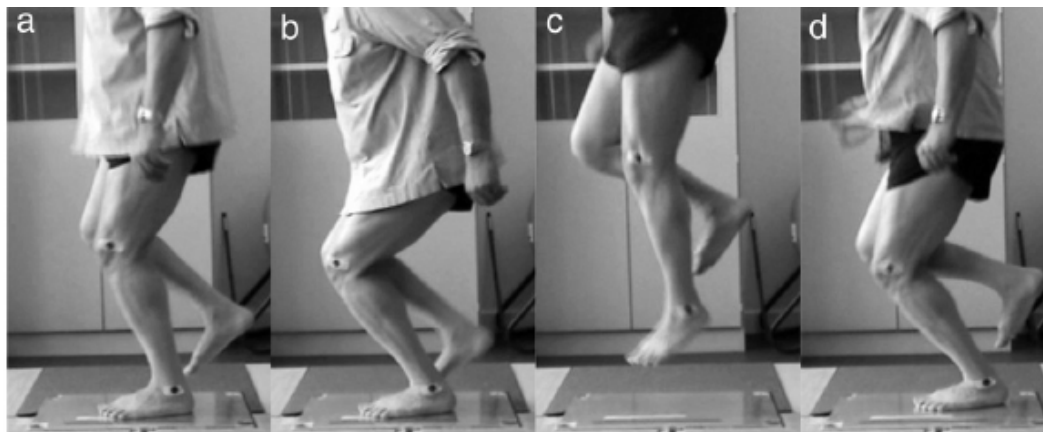
*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$ for pre to post change within groups; p values in bold are significant differences between groups post exercise; η^2 effect size; UD ultradistal; calcium comparisons by t tests. There were no significant differences between the groups at baseline for any variable

Table 2 Baseline characteristics and comparisons within and between groups for exercisers and controls with below average total hip aBMD

Total Hip Variable	Exercise group				Control group				MANOVA	
	Baseline ± SD	Post ± SD	% Change	Cohen's d	Baseline ± SD	Post ± SD	% Change	Cohen's d	p value	η ²
Total hip BMD	0.893 ± 0.078	0.911 ± 0.085	2.0**	-1.415	0.905 ± 0.081	0.882 ± 0.087	-2.6***	2.248	0.000	0.880
Total hip Z	-0.88 ± 0.55	-0.67 ± 0.59	23.2**	-1.387	-0.75 ± 0.55	-0.87 ± 0.65	-15.2***	0.783	0.000	0.687
Total hip T	-0.89 ± 0.65	-0.74 ± 0.71	17.1**	-1.469	-0.80 ± 0.67	-0.99 ± 0.73	22.6***	1.729	0.000	0.864
AP spine BMD	1.144 ± 0.077	1.156 ± 0.099	1.0	-0.244	1.138 ± 0.084	1.127 ± 0.084	-0.9	0.292	0.060	0.231
Total Body BMD	1.141 ± 0.044	1.140 ± 0.045	-0.1	0.082	1.137 ± 0.056	1.116 ± 0.047	1.8***	0.922	0.002	0.497
Total Body BMC (g)	23397 ± 286	2400 ± 291	0.3	0.116	2317 ± 213	2281 ± 219	1.6*	0.484	0.109	0.162
Total Lean (g)	42634 ± 5108	42714 ± 5265	0.2	-0.059	40912 ± 3682	41824 ± 3899	2.2*	-0.608	0.225	0.096
Height (m)	1.675 ± 0.060				1.644 ± 0.045					
Weight (kg)	68.27 ± 14.31	67.86 ± 16.67	0.6	0.075	66.62 ± 11.74	64.84 ± 12.51	2.7	0.299	0.491	0.025
BMI	24.2 ± 4.2	24.0 ± 4.9	0.8	0.099	24.7 ± 4.8	24.0 ± 4.9	2.8	0.311	0.493	0.025
Calcium (mg/day)	697 ± 434	1183 ± 509	70*	0.651	693 ± 433	1109 ± 393	60**	0.648	0.440	
Age (years)	39.6 ± 6.3				39.9 ± 6.7					

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$ for pre to post change within groups; p values in bold are significant differences between groups post-exercise; small p values are for baseline comparisons between groups; η^2 effect size; UD ultradistal; calcium comparisons by t tests. There were no significant differences between the groups at baseline for any variable

High-Intensity Impact Training • Gizon nagusiak



- 50 jauzi monopodal/egunean (2.7-3 BW)
- Femurraren lepoaren azpiko eremua BMDa gehien hobetzen duena (↑1.4%)

KONTZEPTUA • BIOLOGIA	EPIDEMIOLOGÍA	ARRISKU FAKTOREAK	TRATAMENDUA
JARDUERA FISIKOA	JARIATZE HORMONALA	AZELEROMETRIA	JF PROGRAMAREN DISEINUA

High-Intensity Impact Training • Gizon nagusiak

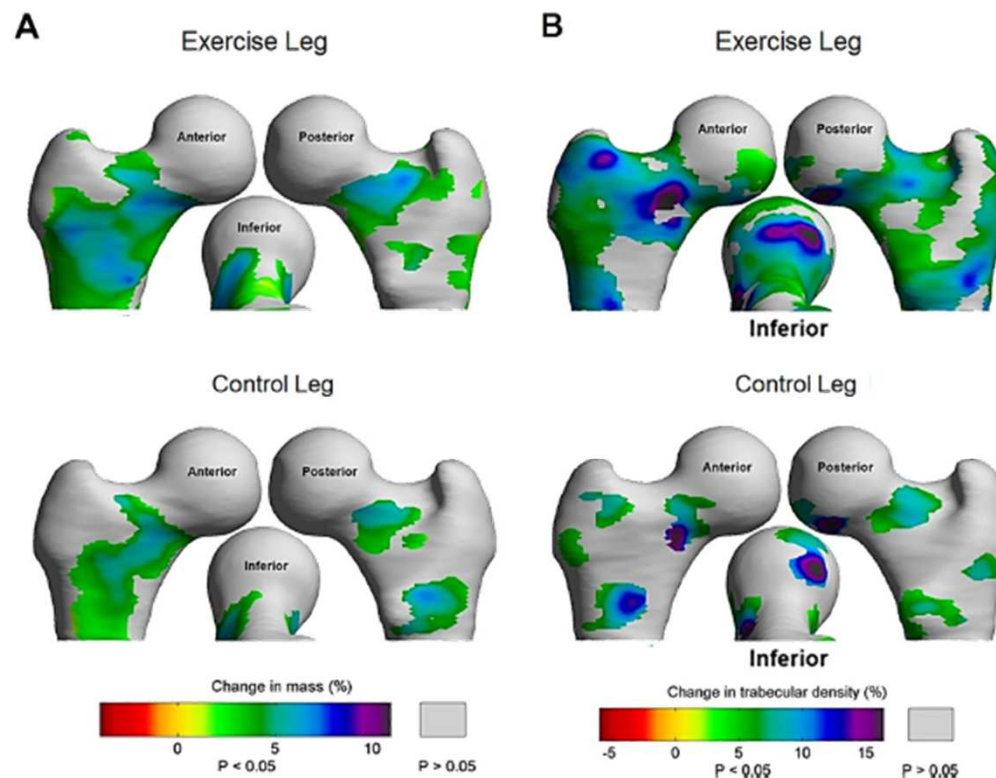


Fig. 2. Changes in cortical surface mass density (A) and endocortical trabecular density (B) in the exercise leg and control leg. Data are expressed as a percentage change from pre-intervention values. 3D color maps are displayed across an average right proximal femur in anterior, posterior, and inferior anatomical views. Areas where there were no statistically significant changes are shown in gray.

- ↑ %2.7 masa kortikalaren azaleraren dentsitatea (lokalizatutako eremuak)
- ↑ %6.4 dentsitate trabekular endokortikala

Allison et al. *JBMR* 2015; 30(9): 1709-1716

Menopausia duten emakumeen HIITaren erantzuna hobea da

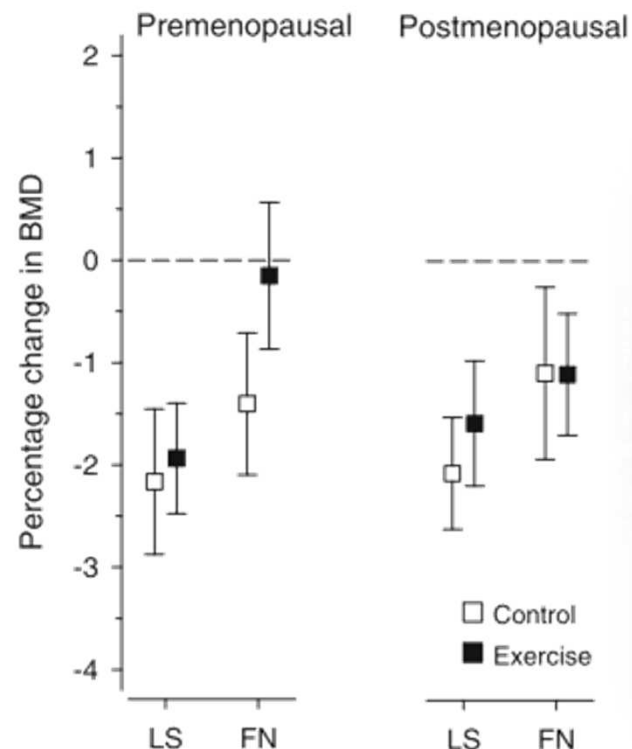


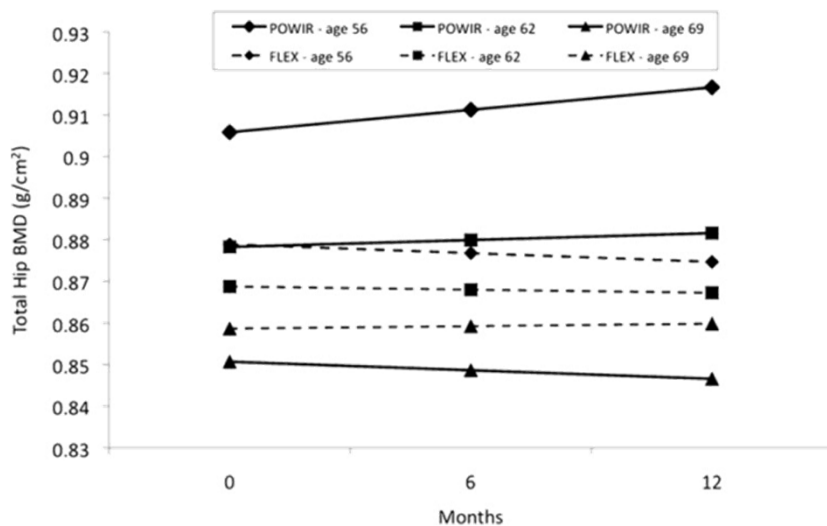
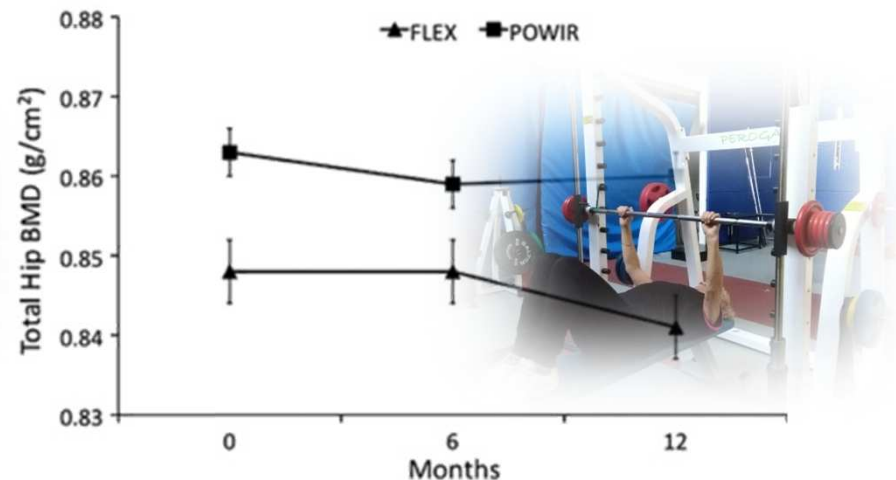
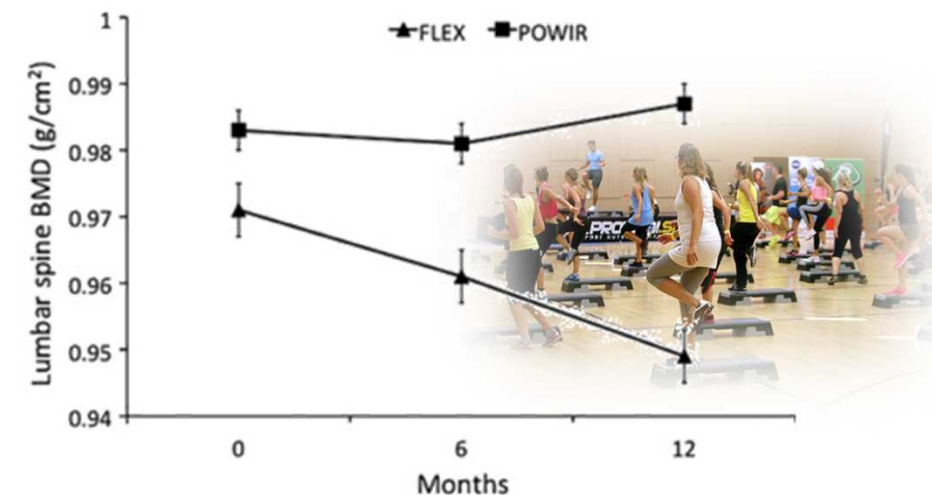
Fig. 2 Percentage BMD changes in the exercise and control groups during the 12-month intervention. **a** Premenopausal women, **b** postmenopausal women

Step Aerobics (150-180 jauzi)+
Circuit Training (jauziak >4BW)
3.3 PreM - 4.4 PostM ses/week



Hormona terapiarekin bularreko minbizia duten emakumeek menopausia ondoren (aromatasa edo tamoxifenoa galaraztekoak) hezurren osaera estimulu mekaniko berdinean txikiagoa da, estrogenoen ↓ dela eta

Bigarren mailako osteoporosia • Bularreko minbizia



DMOa mantentzea-hobetzea (+3/-1.6%) ariketa aerobikoaren interbentzioetan, **indarra** (>70% 1RM, exp) (LS) edota **inpaktua** (ez-ohikoak, 50-100 jauzi/entr eguna) (FN) intentsitatea moderatu-
altuetan vs DMO guztiaren %1.7 - 9 urteko galerak, FN eta LS aktiboak ez diren Menopausia ondorengo CM duten emakumeetan

KONTZEPTUA • KONZEPTE	EPIDEMIOLOGÍA	ARRISKU FAKTOREAK	TRATAMENDUA
JARDUERA FISIKOA	JARIATZE HORMONALA	AZELEROMETRIA	JF PROGRAMAREN DISEINUA

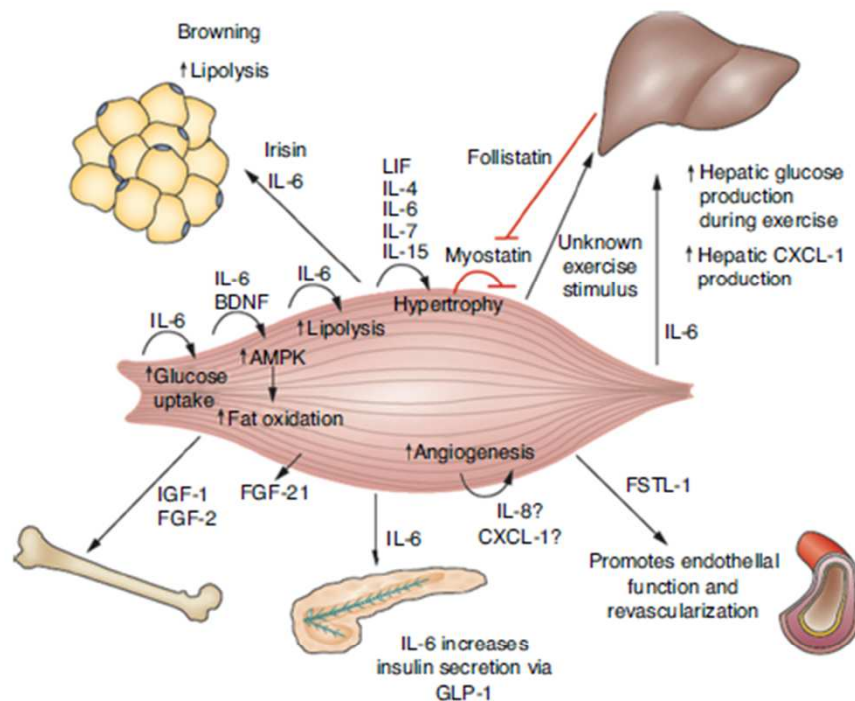
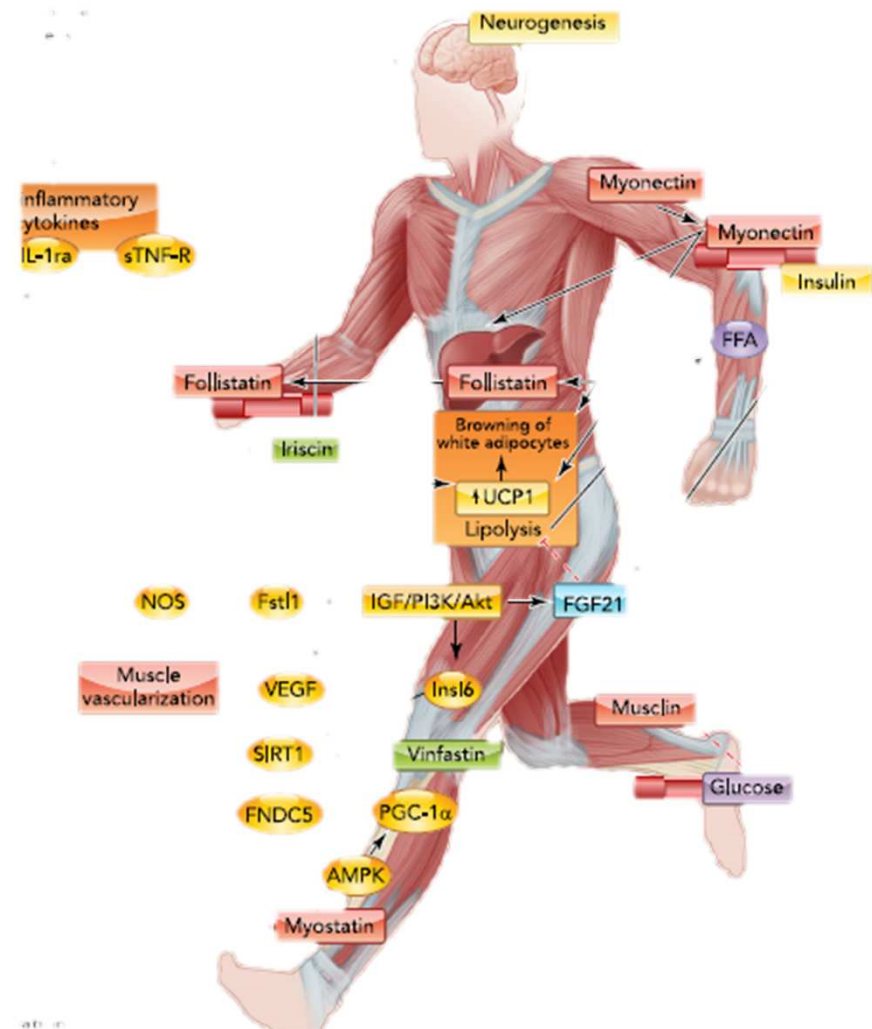
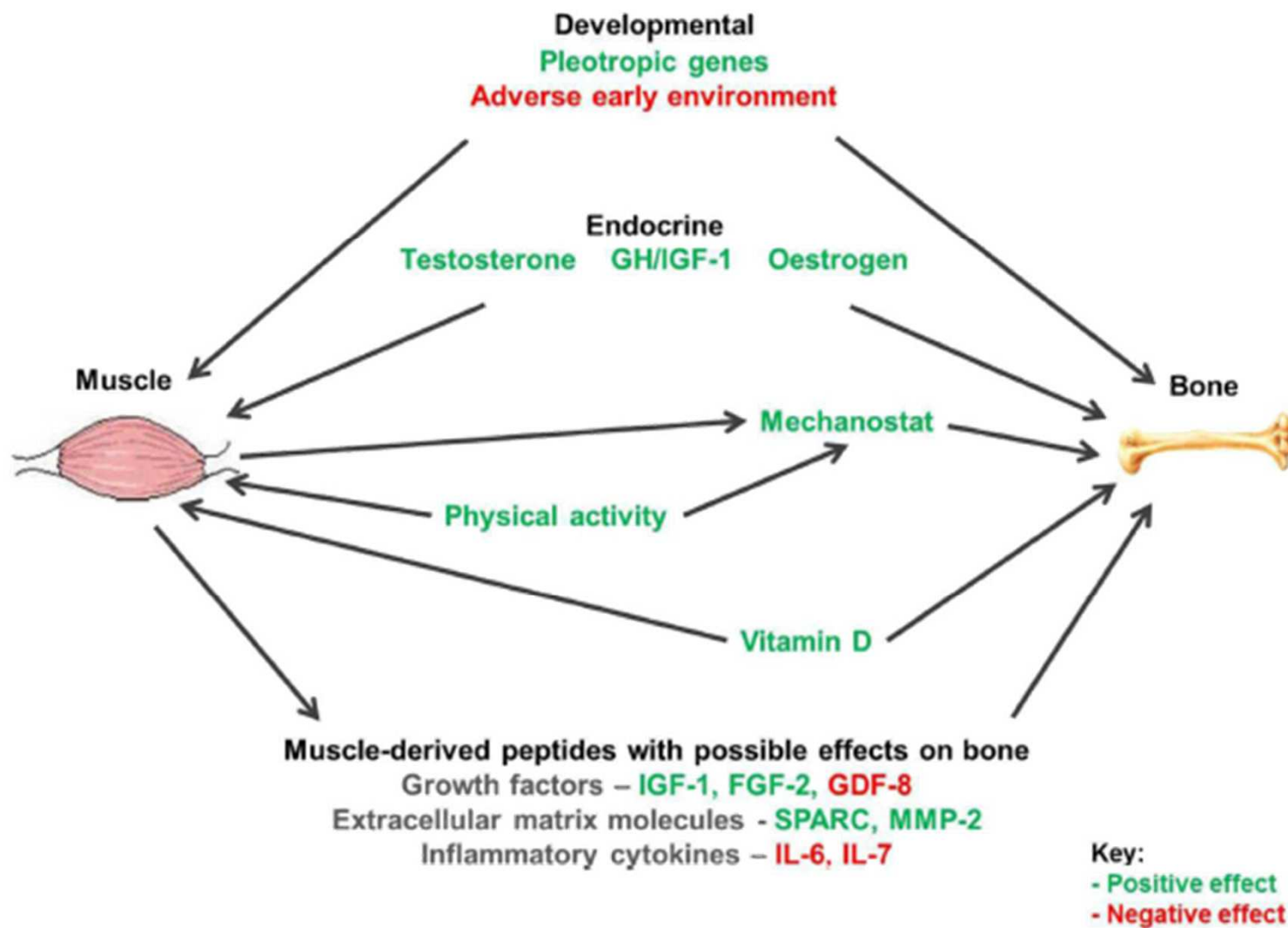
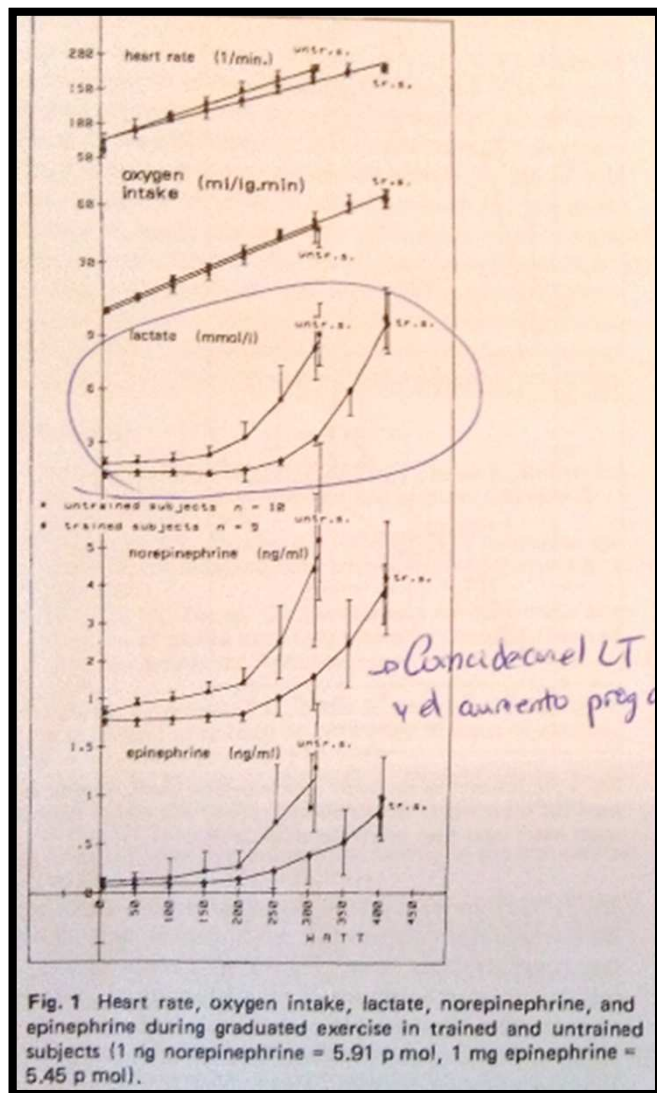


Figure 1 Skeletal muscle is a secretory organ. Leukemia inhibitory factor (LIF), interleukin (IL)-4, IL-6, IL-7, and IL-15 promote muscle hypertrophy. Myostatin inhibits muscle hypertrophy and exercise provokes the release of a myostatin inhibitor, follistatin, from the liver. Brain-derived neurotrophic factor (BDNF) and IL-6 are involved in AMP-activated protein kinase (AMPK)-mediated fat oxidation and IL-6 enhances insulin-stimulated glucose uptake. IL-6 appears to have systemic effects on the liver and adipose tissue and increases insulin secretion via upregulation of GLP-1. Insulin-like growth factor-1 (IGF-1) and FGF-2 are involved in bone formation, and follistatin-related protein 1 improves endothelial function and revascularization of ischemic vessels. Irisin has a role in “browning” of white adipose tissue. Adapted, with permission, from (172).



KONTZEPTUA • BILAKETA	EPIDEMIOLOGÍA	ARRISKU FAKTOREAK	TRATAMENDUA
JARDUERA FISIKOA	JARIATZE HORMONALA	AZELEROMETRIA	JF PROGRAMAREN DISEINUA





- Laktatoaren eta katekolaminen arteko harreman lineal zuzena, entrenamendu-dependente eboluzioa aurkezten dutenak. Inflexio puntua (LT) dosi minimoa da osasun kardiobaskularra eta hezurren osasuna hobetzeko (Leheman et al., 1981)

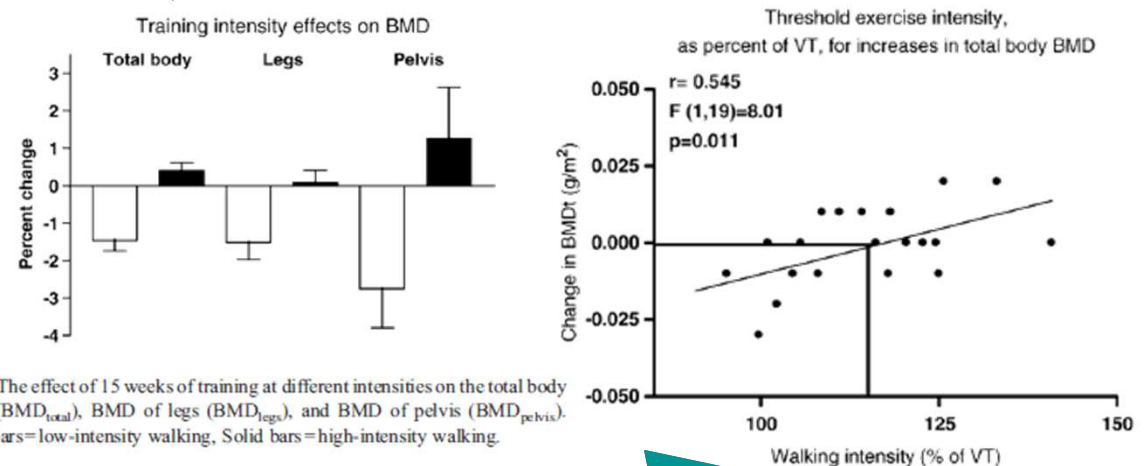


Fig. 1. The effect of 15 weeks of training at different intensities on the total body BMD (BMD_{total}), BMD of legs (BMD_{legs}), and BMD of pelvis (BMD_{pelvis}). Open bars=low-intensity walking, Solid bars=high-intensity walking.

Intentsitate altuko ariketak BMDa estimulatzen du hormona osteogenikoak isuriz IGF-1, PTH y GH

KONTZEPTUA •

EPIDEMIOLOGÍA

ARRISKU FAKTOREAK

TRATAMENDUA

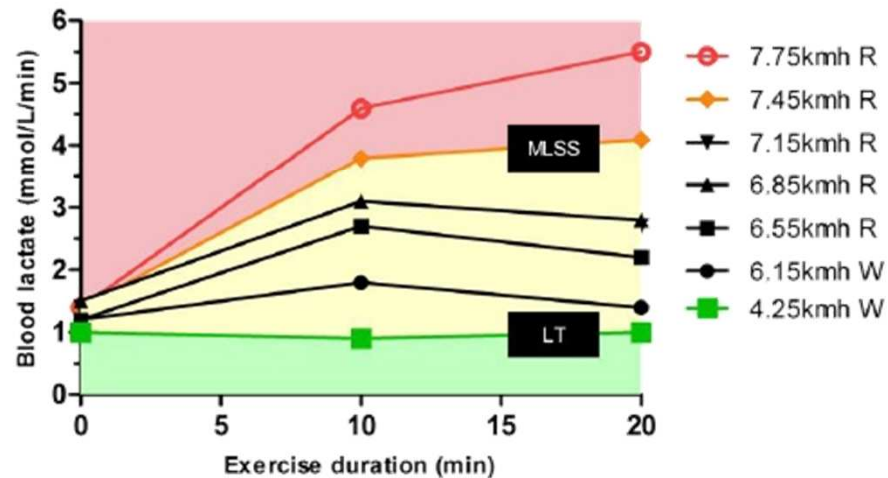
JARDUERA FISIKOAK

JARIATZE HORMONALA

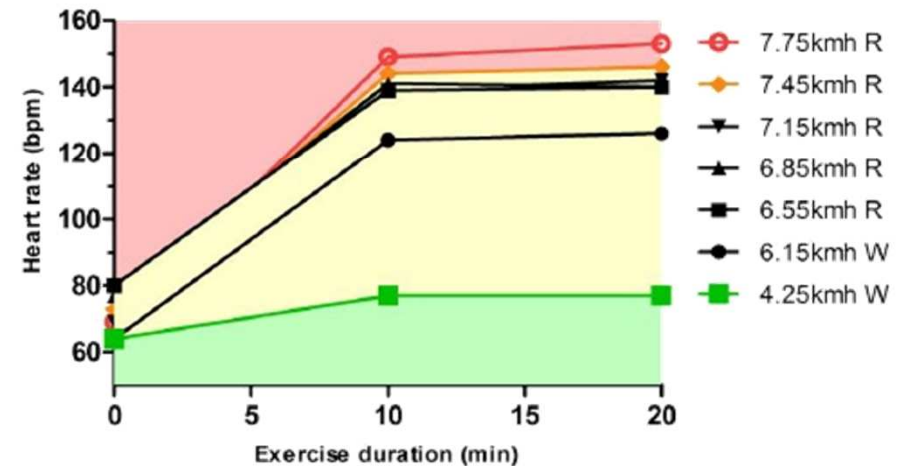
AZELEROMETRIA

JF PROGRAMAREN
DISEINUA

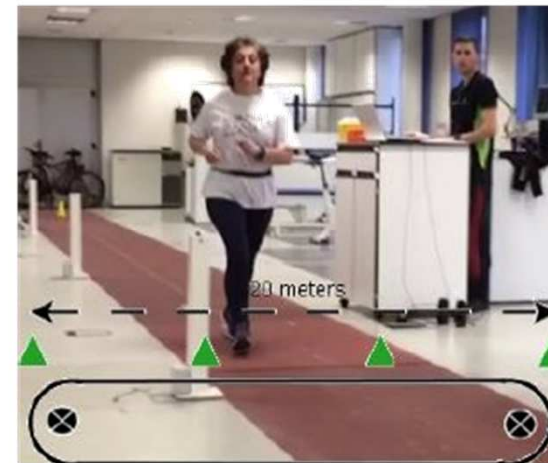
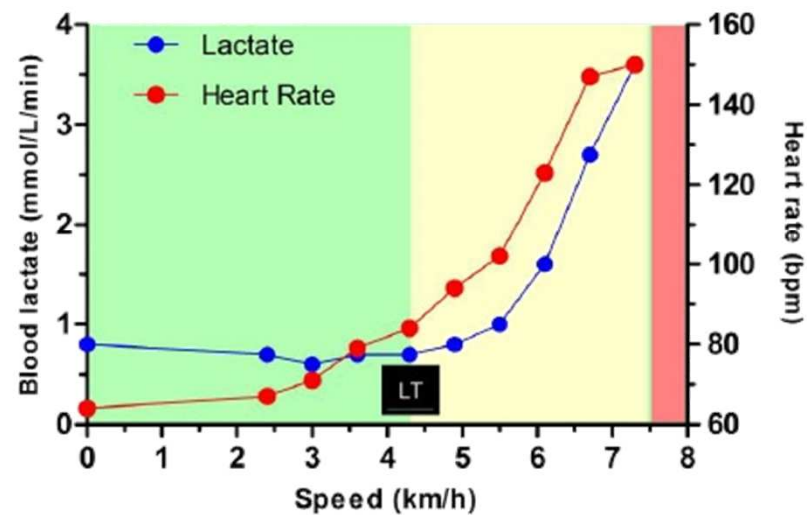
Lactate response to constant speed tests



Heart rate response to constant speed tests



Progressive shuttle walk-running test



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Klabea dosian dago

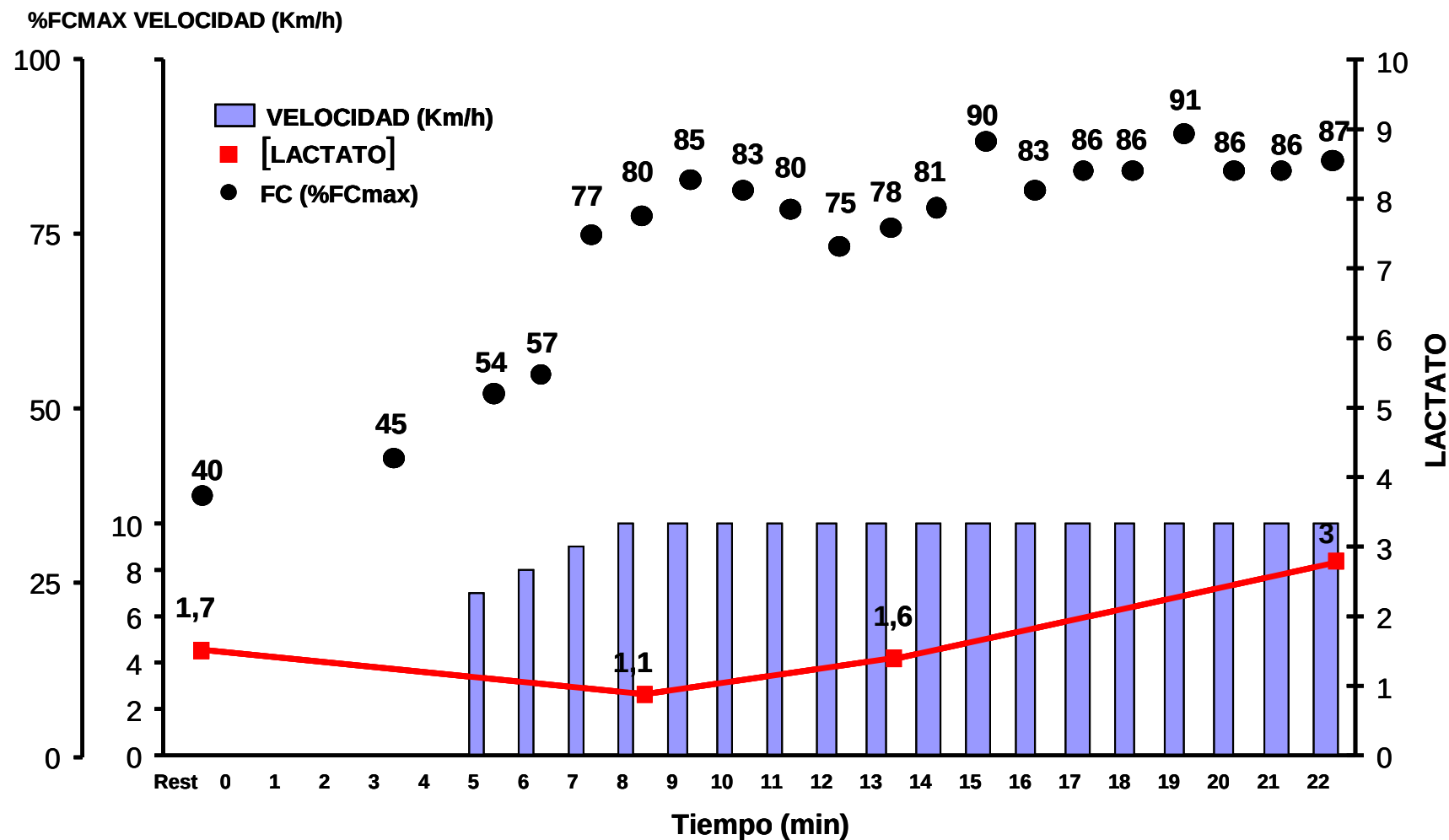


KONTZEPTUA • BIZIAZAKIA	EPIDEMIOLOGÍA	ARRISKU FAKTOREAK	TRATAMENDUA
JARDUERA FISIKOA	JARIATZE HORMONALA	AZELEROMETRIA	JF PROGRAMAREN DISEINUA

OsteoMOD Interval Training 10km/h

Series de 15"-25" al 105%VO_{2max} con 35"-45" de recuperación parado (9.9 METs)

FCmax: 167/min



KONTZEPTUA •

EPIDEMIOLOGÍA

ARRISKU FAKTOREAK

TRATAMENDUA

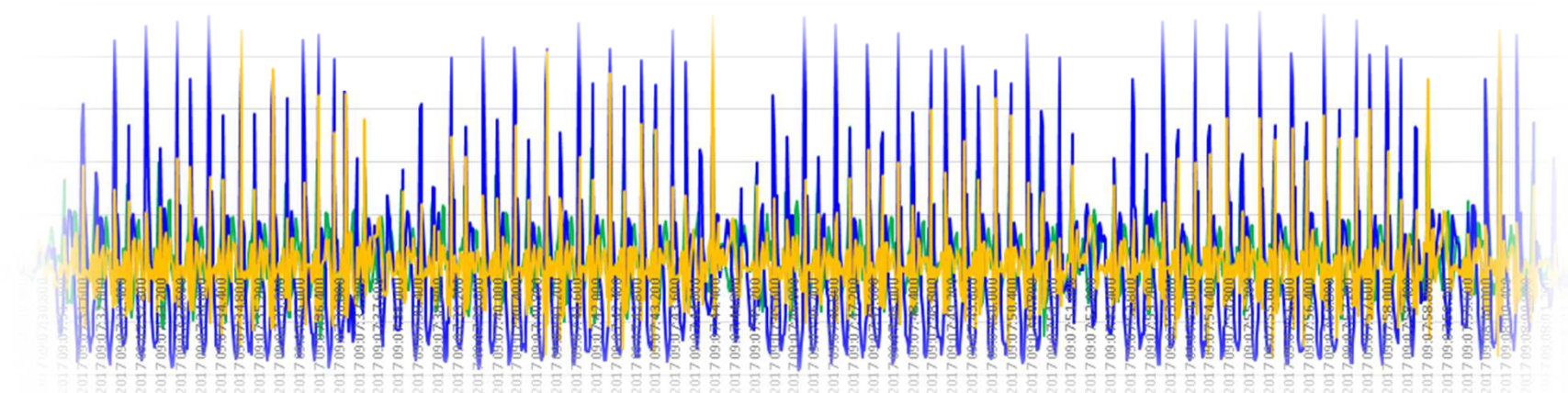
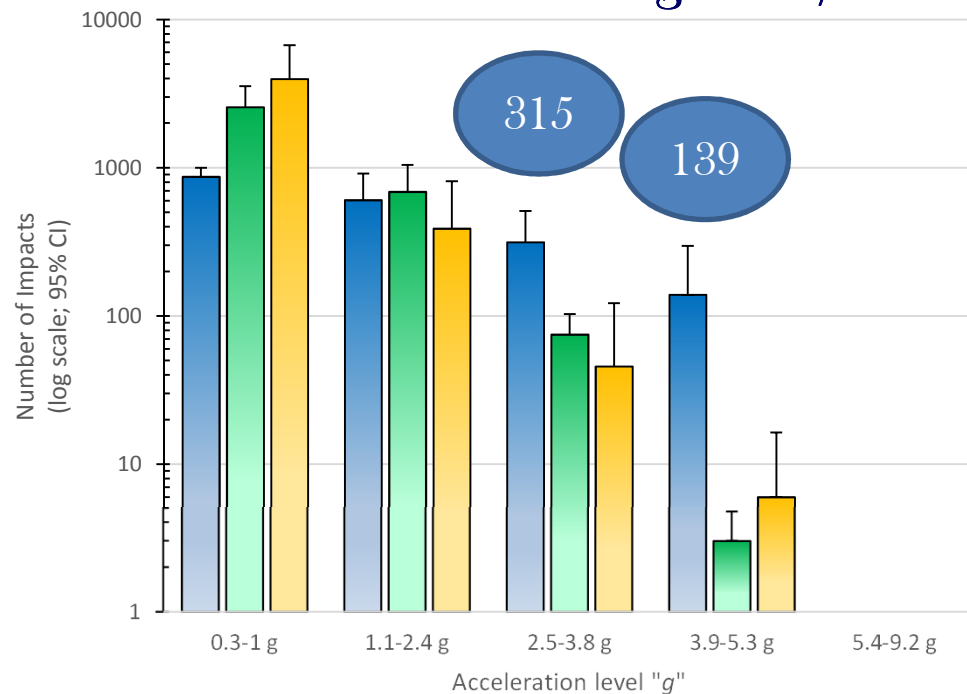
JARDUERA FISIKOA

JARIATZE HORMONALA

AZELEROMETRIA

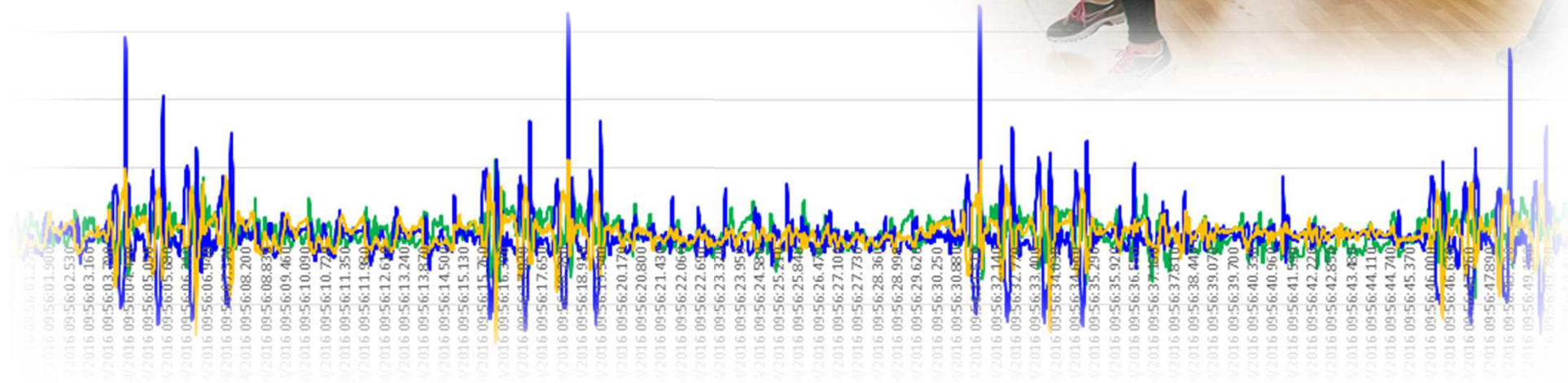
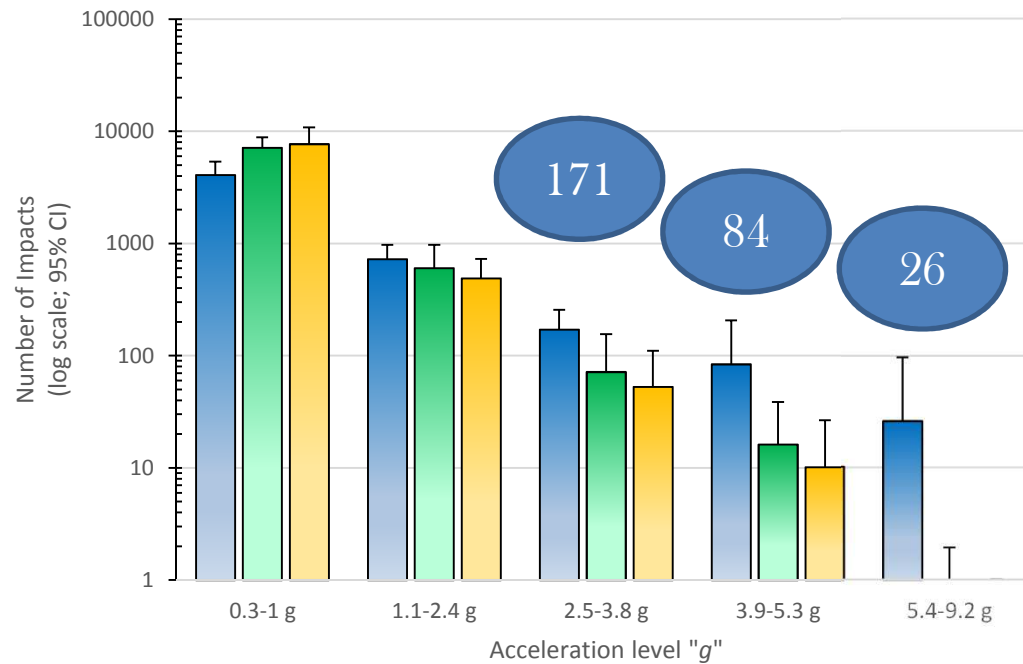
JF PROGRAMAREN
DISEINUA

OsteoMOD Interval Training 10km/h



KONTZEPTUA • BIZIAZAKIA	EPIDEMIOLOGÍA	ARRISKU FAKTOREAK	TRATAMENDUA
JARDUERA FISIKOA	JARIATZE HORMONALA	AZELEROMETRIA	JF PROGRAMAREN DISEINUA

Inpaktuen intentsitatea azelerometroekin neurtzea, ibili, jauzi egin, korrika egin?



Haur eta nerabeetan

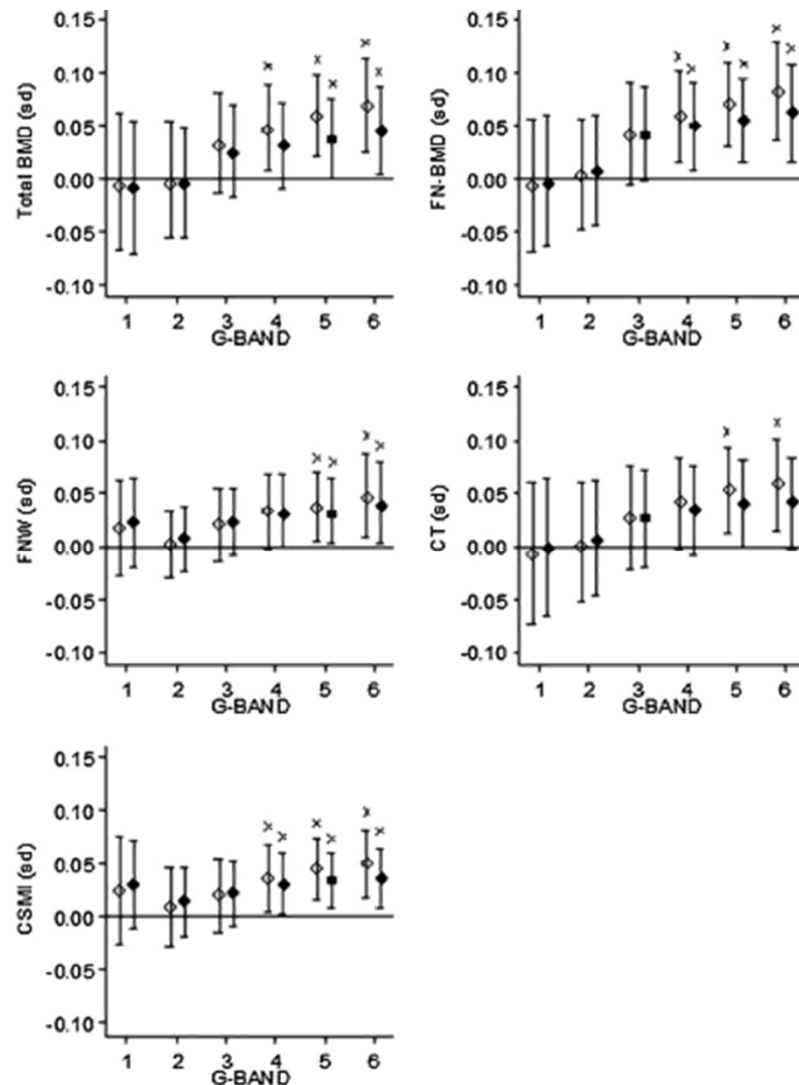
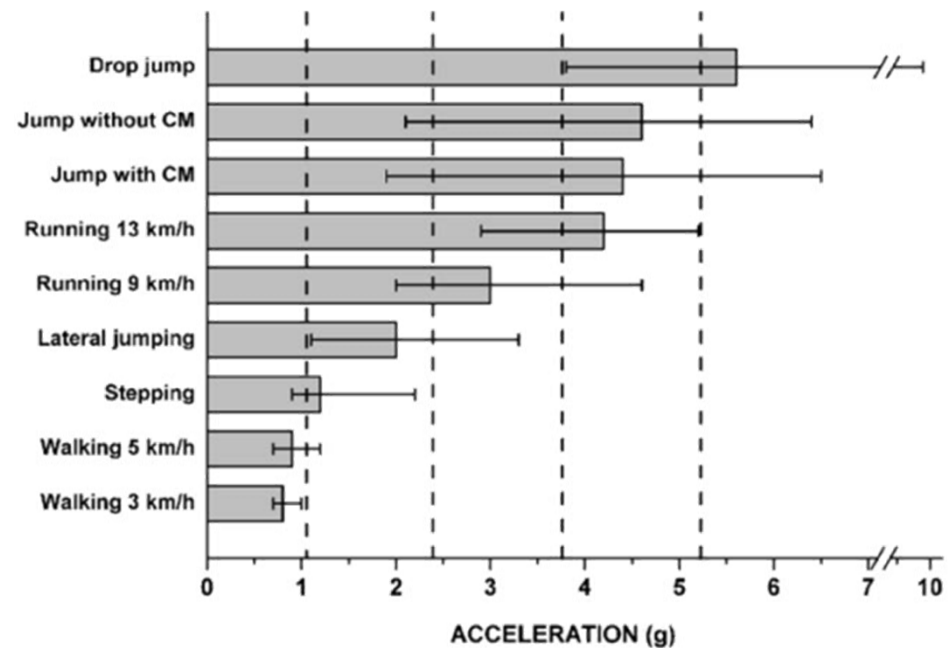
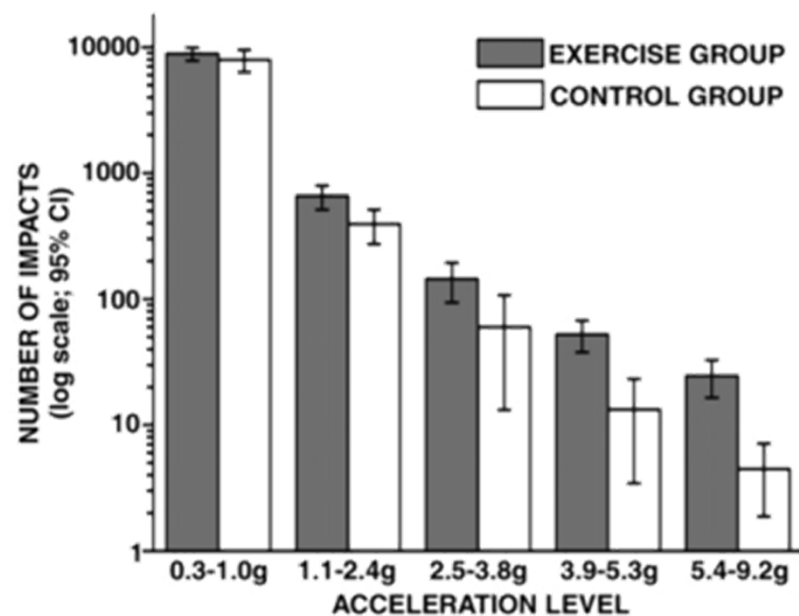


Fig. 1. Results of regression between number of impacts within different activity bands, and hip parameters, in 724 boys and girls combined. Data are shown as beta coefficients (change in SD per doubling in activity) with 95% confidence intervals, based on six different g bands (1 = 0.5–1.1g; 2 = 1.1–2.1g; 3 = 2.1–3.1g; 4 = 3.1–4.2g; 5 = 4.2–5.1g; 6 = > 5.1g) (bootstrap estimates derived from 1000 replicates). Total = total hip BMD; FN = femoral neck; FNW = femoral neck width; CT = cortical thickness; CSMI = cross sectional moment of inertia. x = $p < 0.05$. (○) Basic model (adjusted for age, height, and gender). (●) Additionally adjusted for fat and lean mass.

- Inpaktu kop. **>4.2 g** (jauziak edo korrika egitea **>10km/h**) edo VPA (**>6200 cpm** actigraph) positibo erreala aldakaren DMOan eta hezur masa kortikala nerabeetan. Intentsitate baxuko inpaktu kopurua (0.5-2.1 g) eta intentsitate moderatukoak (2.1-4.2 g) FNren DMOarekin lotura negatiboa (Deere, Sayers, Rittweger, & Tobias, 2012).
- **10km/h korrika egitea egunean/500m** nahikoa da hezurraren DMOa hobetzeko

Deere et al. *JBMR* 2012; 27(9):1887-1895

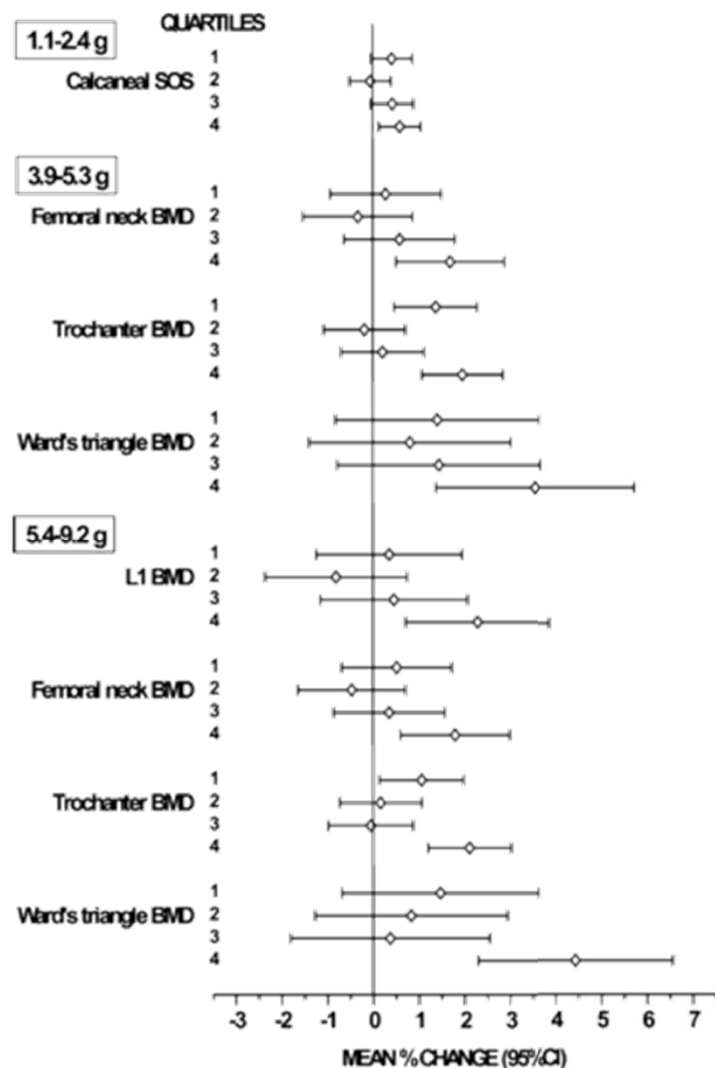
Menopausia aurreko emakumeetan



Impact Training (jumps, stamping, step, running)
PreM W 1 (60') + 2.4 ses (10')/week (12months)

KONTZEPTUA • JARDUERA FISIKOA	EPIDEMIOLOGÍA JARIATZE HORMONALA	ARRISKU FAKTOREAK AZELEROMETRIA	TRATAMENDUA JF PROGRAMAREN DISEINUA
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Menopausia aurreko emakumeetan



Inpaktu kopurua **>3.9 g** FN eta LSren DMOaren aldaketarekin korrelazio positiboak, hurrenez hurren, inpaktu jarduera fisikoa egiten 12 hilabete egon ondoren **menopausia aurreko emakumeetan**. **50-100** norabide anitzeko inpaktuak intentsitate altuan/egunean (Allison et al., 2015; Vainionpää et al., 2006).



Vainionpää et al. *Osteoporosis Int* 2006; 17: 455-463

KONTZEPTUA •

EPIDEMIOLOGÍA

ARRISKU FAKTOREAK

TRATAMENDUA

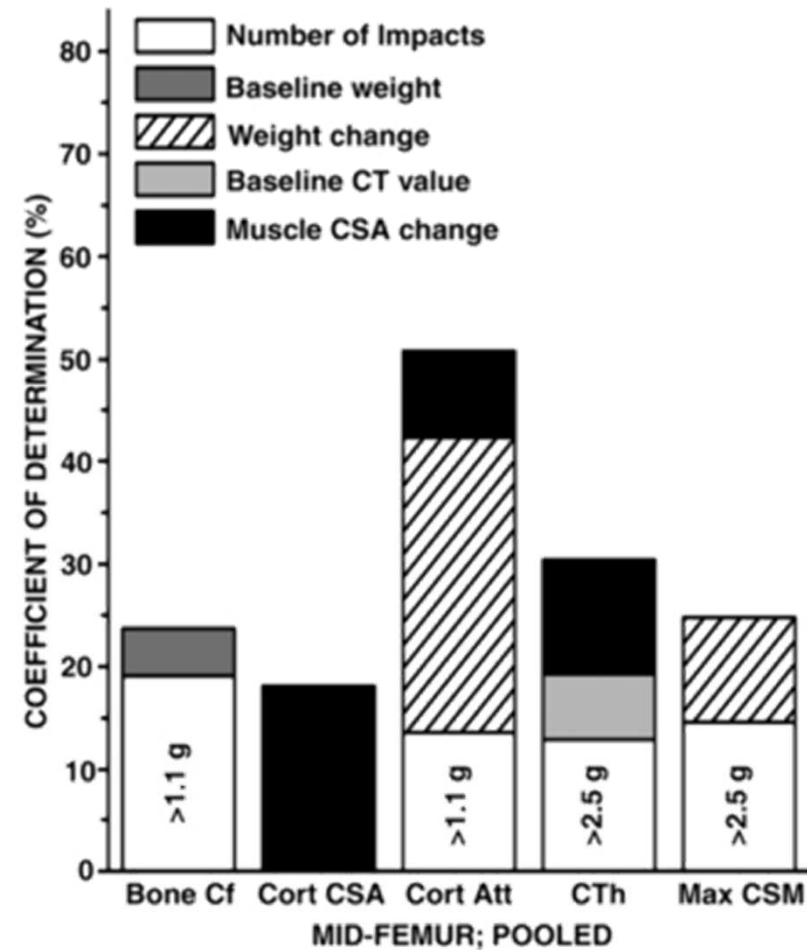
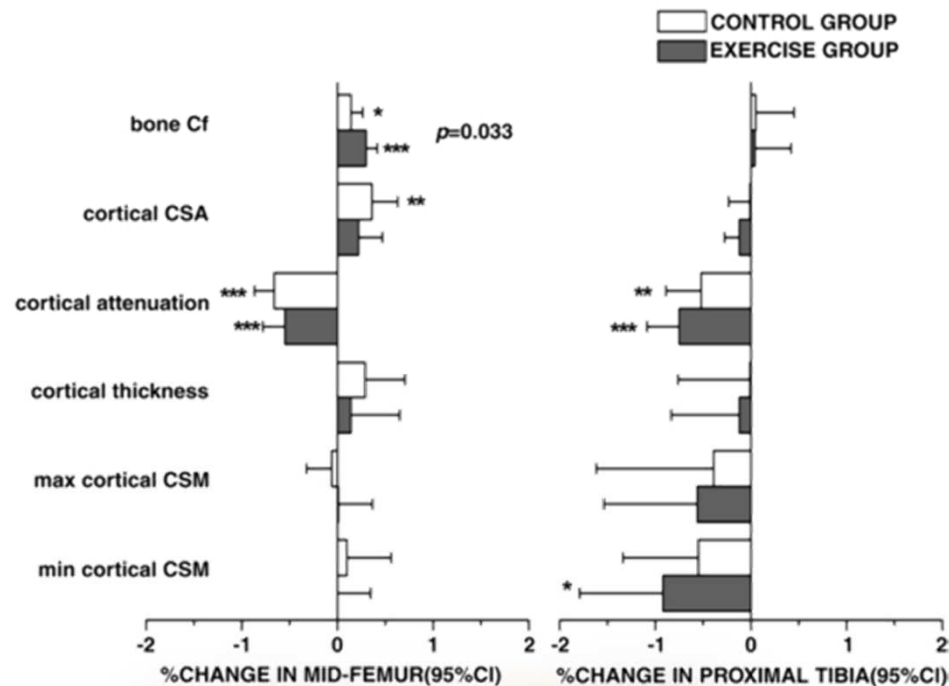
JARDUERA FISIKOA

JARIATZE HORMONALA

AZELEROMETRIA

JF PROGRAMAREN
DISEINUA

Menopausia aurreko emakumeetan



Vainionpää et al. *Bone* 2007; 40: 604-411

Ahola et al. *BMC Musc Dis* 2009; 10:138

Menopausia aurreko emakumeetan

Table 2: Correlation between the impact exercise at 0-3, 0-6 and 0-12 months and bone geometry changes

	Average daily numbers of impacts at different acceleration levels														
	0-3 months					0-6 months					0-12 months				
	0.3-1.0 g	1.1-2.4 g	2.5-3.8 g	3.9-5.3 g	5.4-9.2 g	0.3-1.0 g	1.1-2.4 g	2.5-3.8 g	3.9-5.3 g	5.4-9.2 g	0.3-1.0 g	1.1-2.4 g	2.5-3.8 g	3.9-5.3 g	5.4-9.2 g
Mid-femur Bone circumference	-0.02	0.17	0.07	0.22	0.45 ^(*)	0.01	0.21	0.35	0.37	0.45 [*]	0.04	0.23	0.39 [*]	0.41 [*]	0.45 [*]
Cortical CSA	0.08	0.37	0.35	0.35	0.28	0.06	0.33	0.26	0.41 ^(*)	0.39 ^(*)	0.12	0.36	0.26	0.41 ^(*)	0.43 [*]
Cortical attenuation	0.08	0.43 ^(*)	0.41 ^(*)	0.52 ^(*)	0.49 ^(*)	0.10	0.47 ^(*)	0.51 [*]	0.54 [*]	0.51 [*]	0.18	0.52 [*]	0.52 [*]	0.54 [*]	0.54 [*]
Max cortical CSMI	0.27	0.38 ^(*)	0.29	0.34	0.39 ^(*)	0.29	0.41 ^(*)	0.39 ^(*)	0.38 ^(*)	0.42 ^(*)	0.38 ^(*)	0.46 [*]	0.42 [*]	0.43 [*]	0.45 [*]
Cortical thickness	0.04	0.40 ^(*)	0.33	0.31	0.26	0.00	0.38 ^(*)	0.30	0.44 ^(*)	0.39 ^(*)	0.05	0.41 [*]	0.30	0.44 [*]	0.41 [*]

g acceleration of gravity ($9.81 \text{ m}\cdot\text{s}^{-2}$), CSA cross-sectional area, CSMI cross-sectional moment of inertia.

* $p < 0.05$, after Benjamini-Hochberg correction for multiple comparisons.

(*) the association did not remain significant in multivariate regression models for impacts at later months and other confounding factors. Pearson's correlation coefficients (r) between impact levels in 0-3, 0-6 and 0-12 months, and changes in cortical bone geometry measured with

Hezur geometrian aldaketak intentsitate baxuagoko inpaktuekin (1.1-3.9 g),

Erantzun osteogenikoa saturatzen da ariketa luzean zehar. >4 orduko deskantsuak hezurra sortzeko efektuak bikoizten ditu eta mekanosentsibilitatearen %98a itzultzen da 24h deskantsatu ondoren



Vainionpää et al. *Bone* 2007; 40: 604-411

Ahola et al. *BMC Musc Dis* 2009; 10:138

Belaunean Artrosia duten menopausia ondorengo emakumeetan

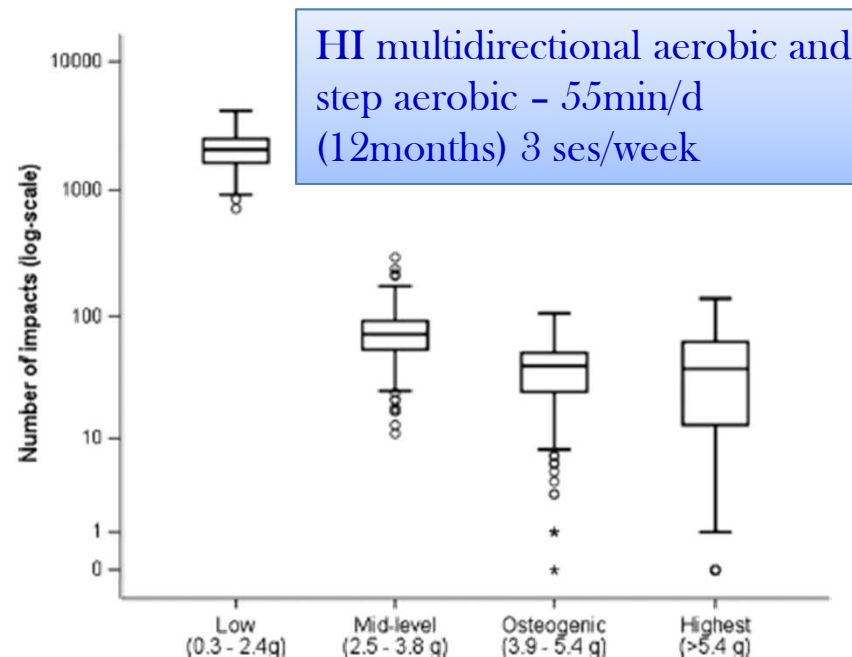


FIGURE 2—Number of impacts at four acceleration levels during the intervention. Bars indicate interquartile range. *Indicates zero acceleration (g) is equated to standing still and $g = 9.81 \text{ m/s}^{-2}$.

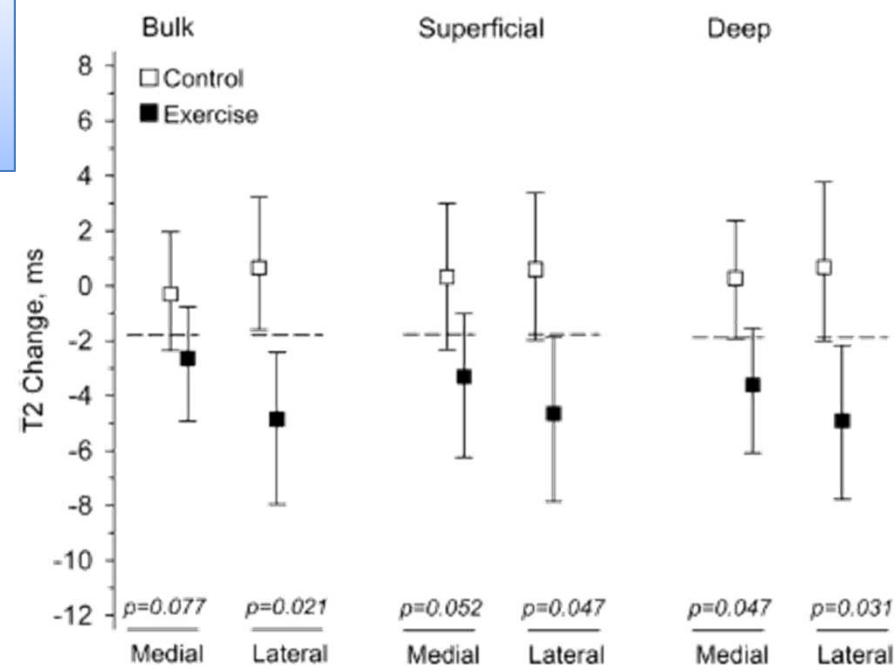


FIGURE 4—Group changes in T_2 relaxation time in different parts of patellar cartilage after the 12-month intervention. Bars indicate 95% CI.

Kartilago rotulianoaren kalitatea hobetzea (ur eta kolageno edukia) inpaktu altuko ariketekin

KONTZEPTUA •

EPIDEMIOLOGÍA

ARRISKU FAKTOREAK

TRATAMENDUA

JARDUERA FISIKOA

JARIATZE HORMONALA

AZELEROMETRIA

JF PROGRAMAREN
DISEÑUA

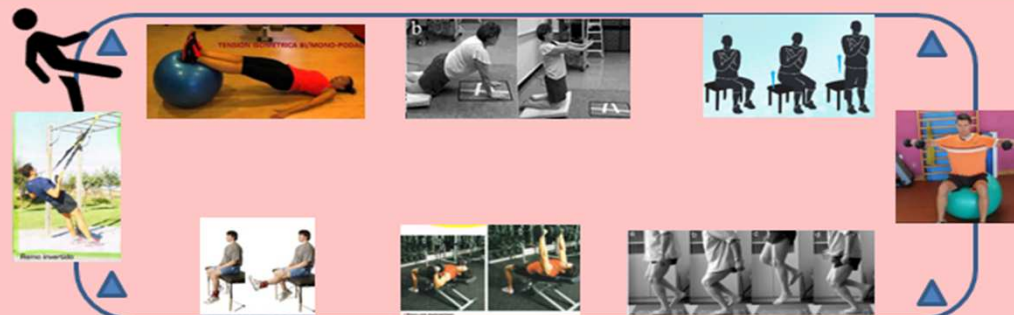
SESION DE EJERCICIO MULTICOMPONENTE OSTEOPENIA • OSTEOPOROSIS

Objetivo: 1) Mejora de la fuerza-masa muscular y generar tensiones medias-altas en los grandes grupos musculares (secreción de factores de crecimiento y miocinas osteogénicas)
 2) Generar unos impactos de media intensidad (1.5-3g) (rango de seguridad) a intensidades > umbral de lactato para provocar un aumento de hormonas anabólicas
 3) Mejora del equilibrio y prevención de caídas

Duración: 60'

Grupo muscular - Ejercicio		Rep.Graf.	Series	Rep.	Carac.Es	Descanso
ACTIVACIÓN Y EQUILIBIO (10')	Equilibrio y movilidad • Por equipos todos en un círculo grande separados por un contrincante, pasar la pelota a compañero con bote en el medio 2 pelotas por equipo. Posición <u>cigüeña</u> manteniendo el equilibrio.		3	1'	-	15"
	Tensiones explosivas TS • En un espacio reducido (7.5x7.5m) un equipo trata de golpear a los contrincantes golpeando y manteniendo 3 globos en el aire. Un toque por jugador. El oponente golpeado se queda en el sitio a pata coja.		2	2'	-	30"
IMPACTO – SALTOS MULTIDIRECCIONAL (20')	Cruzar el río sallitos • Un equipo en cada extremo del río (aros). 2 de cada equipo en los laterales para lanzar balones y evitar que el equipo contrario llegue a la orilla del río. Para cruzar, hay que saltar con dos piernas de aro en aro hasta el otro lado para coger una carta (gana el que antes coge el AS)		2	3'	-	1'
	Aerobic con saltos multidireccionales • Lateral – salto lateral Doble – salto lateral <u>Step</u> – Salto a <u>Step</u> y abajo <u>Step</u> Rodilla/brazo – Salto a <u>step</u> y abajo W – Saltos diagonales a cada lado Paso con sentadilla – Salto Baldosa		2	4'	-	1'

CIRCUITO FUERZA EXPLOSIVA – IMPACTO Y AERÓBICO VII (25')
 Circuito con 8 postas en la que hacen un nº de reps determinado en cada posta con un **40-70%RM** y **50% del carácter del esfuerzo y ejecución rápida/explosiva** (Hacer la mitad de repeticiones en relación a las máxima posibles) + 1' caminar FC 110-120%LT **alrededor de 7km/h** (los más descondicionados de forma interválica para no pasarse de FC y los de mejor capacidad aeróbica de continuo caminar o trote en función del riesgo de fractura) 50 metros de pista (20x5) = 26seg/vuelta o 2 vueltas en 56seg a 7km/h / 30seg rec. antes de posta



Start early and keep jumping lifelong

