Menopause, obesity and sarcopenia

Prof. dr. Patrick Calders

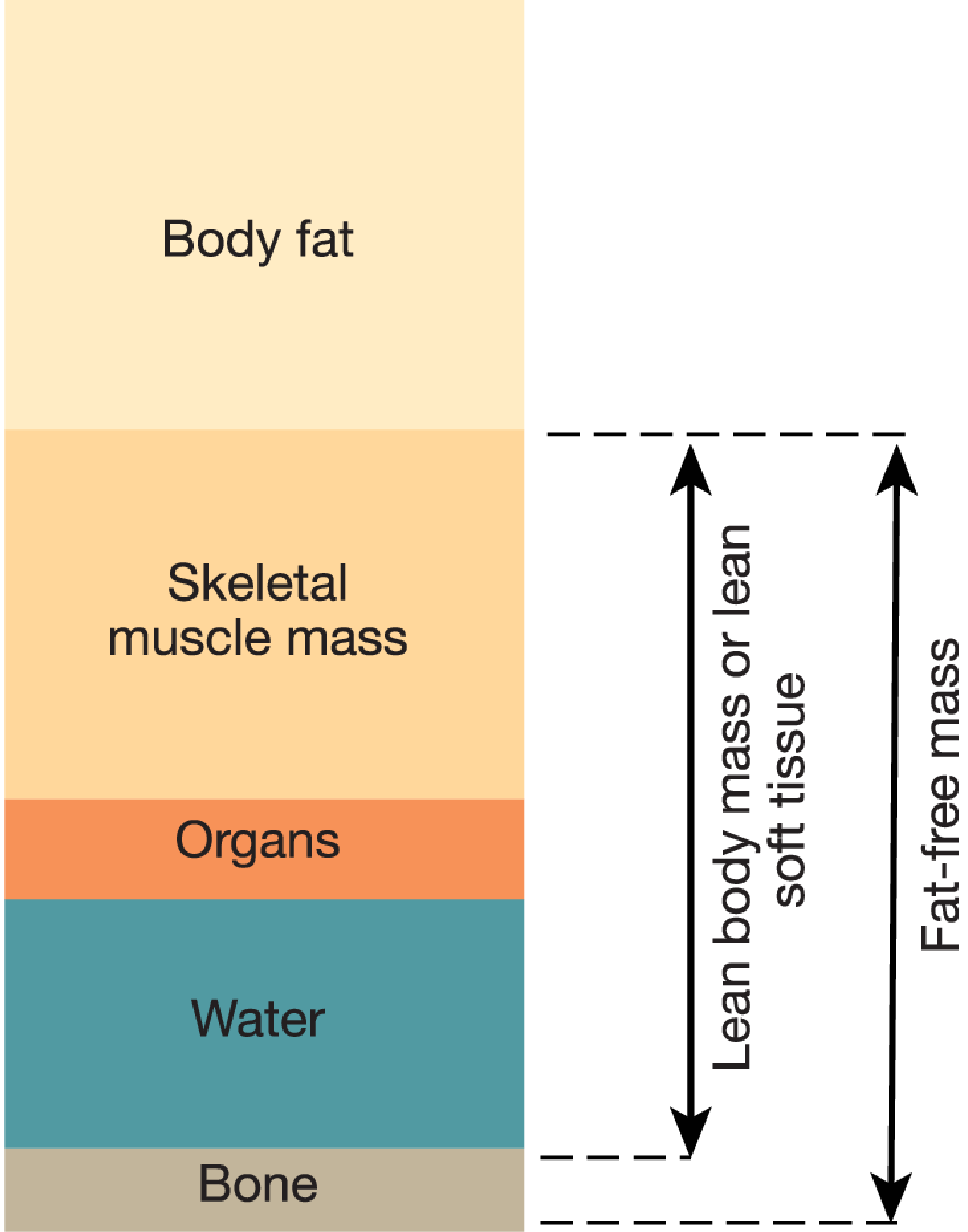
Department of Rehabilitation Sciences

Faculty of Medicine and Health Sciences

Ghent University

UNIVERSITEIT GENT

Body composition



Body composition

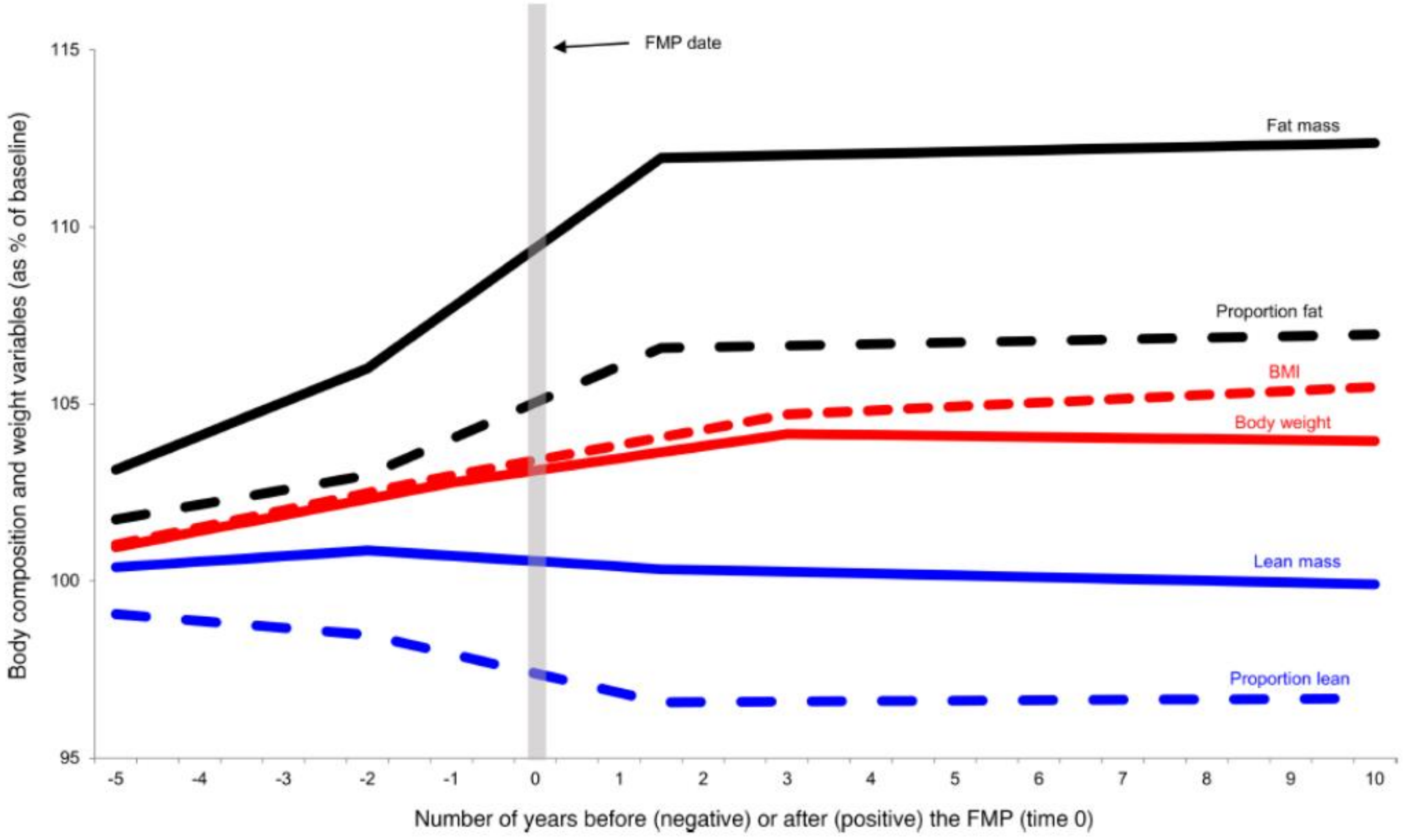
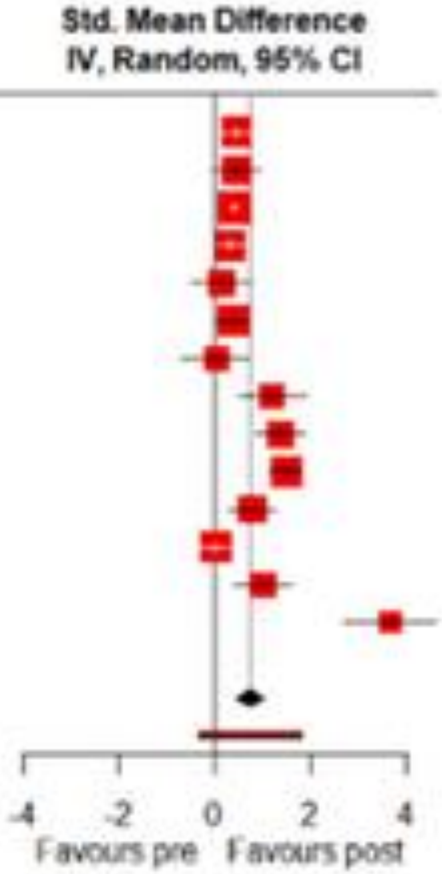


Figure 2. Model-predicted trajectories of body composition and body weight outcomes relative to the time prior to or after the FMP, SWAN. Values shown are for an average study participant (i.e., with each model covariate set at its analysis sample mean). Covariates were age at FMP, race, SWAN study site, and HT use.

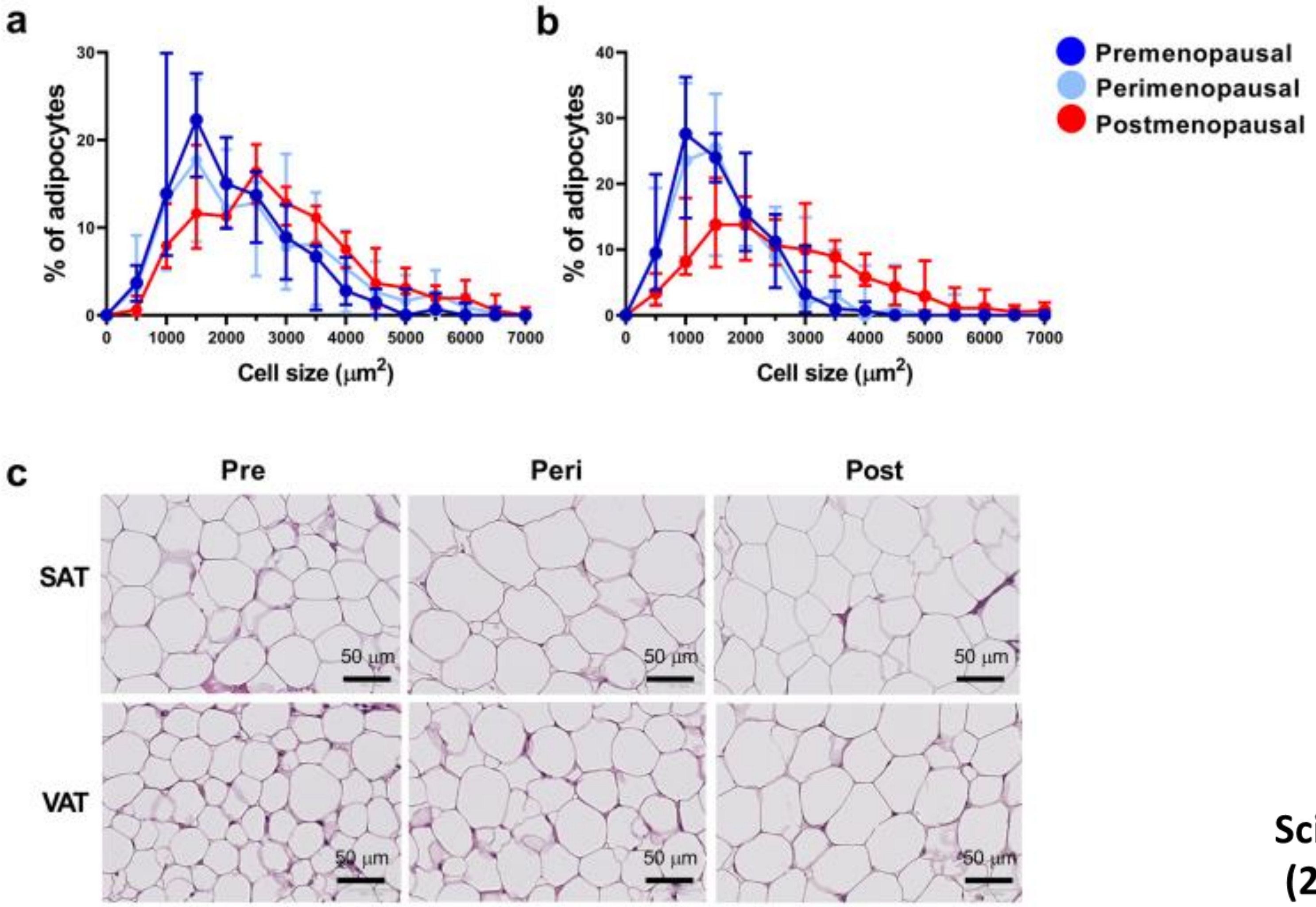
[B]

Study	SMD	SE	Weight	Std. Mean Difference IV, Random, 95% CI
Ben Ali et al. 2016 [15]	0.4589	0.1416	8.4%	0.46 [0.18; 0.74]
Cicero et al. 2011 [18]	0.4463	0.2452	7.2%	0.45 [-0.03; 0.93]
Jeon et al. (a) 2011 [49]	0.4088	0.0463	9.1%	0.41 [0.32; 0.50]
Jeon et al. (b) 2011 [49]	0.3270	0.1514	8.3%	0.33 [0.03; 0.62]
Olszanecka et al. (a) 2010 [32]	0.1449	0.3170	6.3%	0.14 [-0.48; 0.77]
Olszanecka et al. (b) 2010 [32]	0.3855	0.1638	8.2%	0.39 [0.06; 0.71]
Riesco et al. 2012 [20]	0.0388	0.3660	5.7%	0.04 [-0.68; 0.76]
Santos-Marcos et al. 2018 [41]	1.2087	0.3586	5.7%	1.21 [0.51; 1.91]
Sieminska et al. 2005 [14]	1.3716	0.2658	6.9%	1.37 [0.85; 1.89]
Stefanska et al. 2014 [35]	1.4950	0.1668	8.1%	1.50 [1.17; 1.82]
Taleb-Belkadi et al. 2016 [36]	0.7818	0.2420	7.2%	0.78 [0.31; 1.26]
Tariq et al. 2016 [39]	0.0149	0.1444	8.4%	0.01 [-0.27; 0.30]
Tufano et al. (a) 2004 [53]	1.0081	0.3065	6.4%	1.01 [0.41; 1.61]
Tufano et al. (b) 2004 [53]	3.6723	0.4949	4.3%	3.67 [2.70; 4.64]
Total (95% CI)			**100.0%**	**0.74 [0.47; 1.02]**
Prediction interval				**[-0.32; 1.80]**

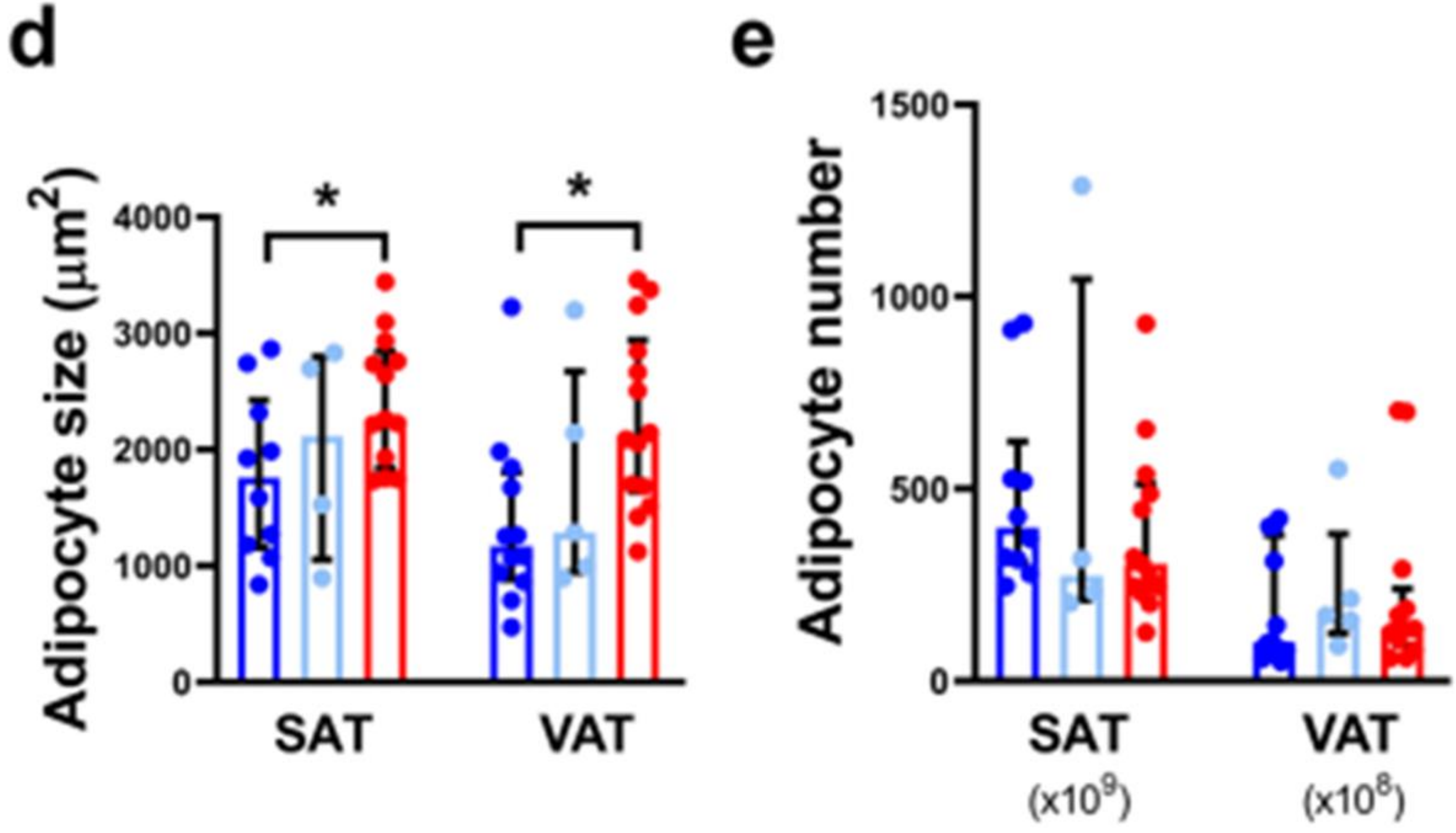
Heterogeneity: $Tau^2 = 0.2164$; $Chi^2 = 115.22$, df = 13 ($P < 0.01$); $I^2 = 89\%$



Waist



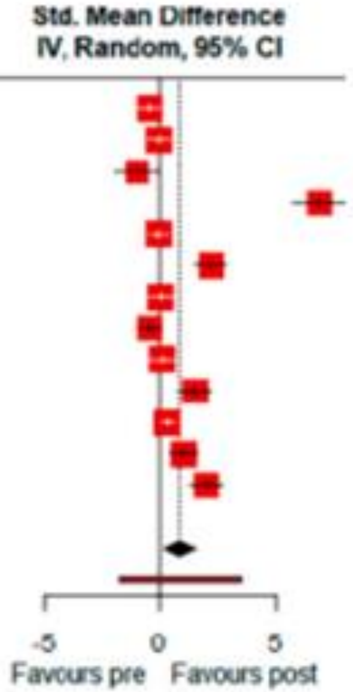
Scientifc Reports
(2021) 11:14750


d
Adipocyte size (μm2)
4000
3000
2000
1000
0
*
*
SAT
VAT
e
Adipocyte number
1500
1000
500
0
SAT
(x10^9)
VAT
(x10^8)

[B]

Study	SMD	SE	Weight	Std. Mean Difference IV, Random, 95% CI
Ayub et al. 2006 [19]	-0.4454	0.2289	8.0%	-0.45 [-0.89; 0.00]
Gupta et al. 2009 [28]	-0.0096	0.2407	8.0%	-0.01 [-0.48; 0.46]
Hayase et al. 2002 [48]	-0.9955	0.4998	7.0%	-1.00 [-1.98; -0.02]
Hummadi et al. 2019 [30]	6.8970	0.5556	6.7%	6.90 [5.81; 7.99]
Jurimae et al. 2007 [21]	-0.0311	0.2103	8.0%	-0.03 [-0.44; 0.38]
Kanaley et al. 2001 [50]	2.2111	0.3597	7.6%	2.21 [1.51; 2.92]
Kontogianni et al. 2004 [51]	0.0715	0.2413	8.0%	0.07 [-0.40; 0.54]
Maestrini et al. (a) 2018 [31]	-0.4419	0.2781	7.9%	-0.44 [-0.99; 0.10]
Maestrini et al. (b) 2018 [31]	0.1267	0.2675	7.9%	0.13 [-0.40; 0.65]
Rouen et al. 2010 [42]	1.5061	0.3676	7.5%	1.51 [0.79; 2.23]
Tariq et al. 2016 [39]	0.3326	0.1454	8.2%	0.33 [0.05; 0.62]
Tufano (a) et al. 2004 [53]	1.0043	0.3063	7.8%	1.00 [0.40; 1.60]
Tufano (b) et al. 2004 [53]	2.0299	0.3721	7.5%	2.03 [1.30; 2.76]
Total (95% CI)			**100.0%**	**0.88 [0.22; 1.53]**
Prediction interval				**[-1.77; 3.52]**

Heterogeneity: $Tau^2 = 1.3305$; $Chi^2 = 235.04$, df = 12 ($P < 0.01$); $I^2 = 95\%$

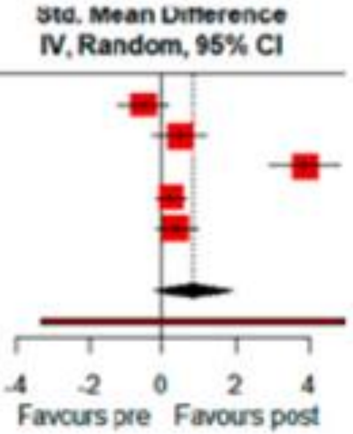


Leptin

[D]

Study	SMD	SE	Weight	Std. Mean Difference IV, Random, 95% CI
Park et al. 2019 [13]	-0.5124	0.3470	20.0%	-0.51 [-1.19; 0.17]
Riesco et al. 2012 [20]	0.4686	0.3709	19.8%	0.47 [-0.26; 1.20]
Santos-Marcos et al. 2018 [41]	3.8940	0.4876	18.6%	3.89 [2.94; 4.85]
Sites et al. 2001 [12]	0.2139	0.2126	21.1%	0.21 [-0.20; 0.63]
Yasui et al. 2007 [16]	0.3696	0.2876	20.5%	0.37 [-0.19; 0.93]
Total (95% CI)			**100.0%**	**0.83 [-0.24; 1.91]**
Prediction interval				**[-3.30; 4.97]**

Heterogeneity: $Tau^2 = 1.3848$; $Chi^2 = 58.89$, df = 4 ($P < 0.01$); $I^2 = 93\%$



IL-6

Table 1. *Subject characteristics*

Variable	Pre $n = 30$	EPeri $n = 31$	LPeri $n = 30$	EPost $n = 26$	LPost $n = 27$	P Value
Age, yr	38 ± 6	50 ± 3	50 ± 4	55 ± 3	62 ± 4	**<0.001**
Weight, kg	65.9 ± 9.8	71.3 ± 10.9	67.3 ± 11.9	71.8 ± 12.9	66.6 ± 14.0	0.19
Height, cm	165 ± 6	165 ± 6	166 ± 7	165 ± 6	161 ± 7	0.053
BMI, kg/m^2	24.3 ± 3.8	26.1 ± 3.9	24.5 ± 3.9	26.6 ± 5.1	25.7 ± 5.1	0.21
WC, cm	80.6 ± 8.0	84.4 ± 10.4	82.1 ± 11.9	87.9 ± 13.9	83.5 ± 10.7	0.23
Total lean mass, kg	42.2 ± 3.6	44.3 ± 5.7	40.5 ± 5.1	42.3 ± 6.3	39.0 ± 5.5	**<0.01**
ALM, kg	17.8 ± 1.7	18.7 ± 2.7	16.8 ± 2.7	17.6 ± 3.1	16.0 ± 2.6	**<0.01**
Total fat mass, kg	21.6 ± 7.7	24.7 ± 6.9	24.8 ± 8.1	27.4 ± 8.0	25.7 ± 9.6	0.10
Trunk fat mass, kg	9.5 ± 4.0	12.1 ± 4.2	12.0 ± 4.6	13.2 ± 4.8	12.4 ± 4.9	**<0.05**
Estradiol, pg/mL[a,b]	79 [64, 110]	70 [37, 141]	34 [10, 94]	11 [10, 15]	10 [10, 14]	**<0.001**
Estrone, ng/dL[a,b]	61 [41, 70]	60 [34, 88]	43 [30, 69]	26 [24, 33]	26 [23, 37]	**<0.001**
FSH, µIU/mL[b]	6.5 ± 3.4	22.0 ± 30.0	64.1 ± 35.5	72.1 ± 26.1	84.1 ± 33.3	**<0.001**
Progesterone, ng/dL[a,b]	0.4 [0.2, 0.6]	0.5 [0.2, 0.8]	0.3 [0.2, 0.5]	0.3 [0.1, 0.4]	0.2 [0.1, 0.4]	**<0.01**
Testosterone, ng/dL[a,b]	24 [22, 33]	22 [17, 35]	20 [17, 25]	18 [17, 23]	17 [17, 35]	0.32
$\dot{V}O_{2peak}$, $mL \cdot kg^{-1} \cdot min^{-1}$[c]	31.2 ± 6.4	28.3 ± 4.8	27.5 ± 5.9	26.3 ± 3.6	24.7 ± 7.2	**<0.001**

Data are means ± standard deviation or [a]median [interquartile range] for n subjects. [b]$n = 118$, [c]$n = 139$.ALM, appendicular lean mass; BMI, body mass index; EPeri, early perimenopausal; EPost, early postmenopausal; FSH, follicle stimulating hormone; LPeri, late perimenopausal; LPost, late postmenopausal; Pre, premenopausal; $\dot{V}O_{2peak}$, peak aerobic capacity; WC, waist circumference. Significant P values are in bold.

Table 2. *Prevalence of sarcopenia*

Variable	Pre $n = 30$	EPeri $n = 31$	LPeri $n = 30$	EPost $n = 26$	LPost $n = 27$
Below 5.31 kg/m^2 of ALMi[a]					
Sarcopenic, *n* (%)	0 (0)	0 (0)	3 (10.0)	5 (11.5)	5 (18.5)
Below 5.67 kg/m^2 of ALMi[b]					
Sarcopenic, *n* (%)	2 (6.7)	1 (3.2)	9 (30.0)	7 (26.9)	9 (33.3)

n = no. of subjects. ALMi, appendicular lean mass adjusted by square of height (m^2); EPeri, early perimenopausal; EPost, early postmenopausal; LPeri, late perimenopausal; LPost, late postmenopausal; Pre, premenopausal. [a]A cut point from Fielding et al. (3) and Newman et al. (27); [b]≥2 SD below the premenopausal group of the present study.

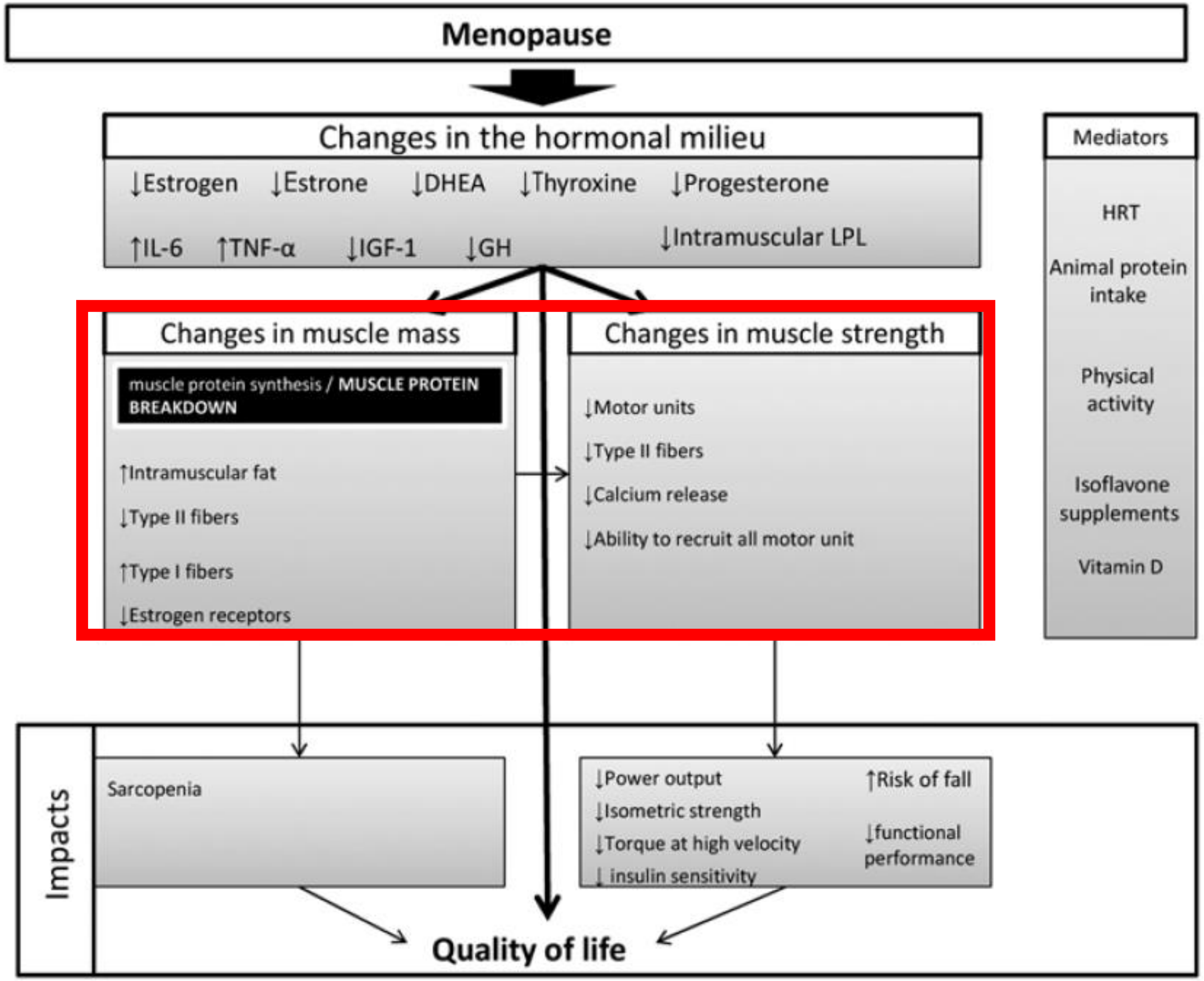
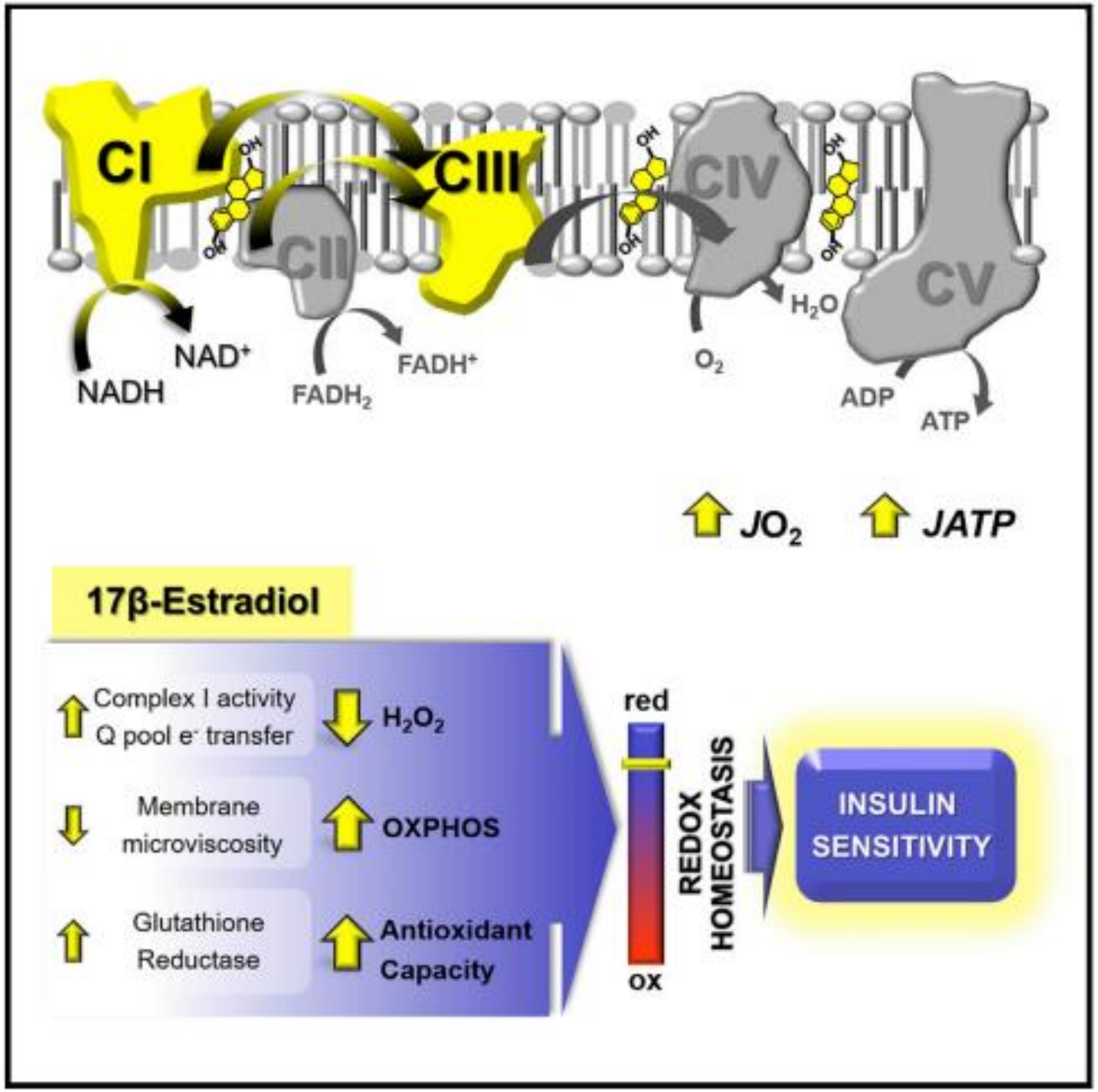


Figure 1. Menopause-related changes on muscle mass and its impacts on different characteristics that contribute to quality of life.

Graphical Abstract



Cell Metabolism
27, 167–179, January 9, 2018

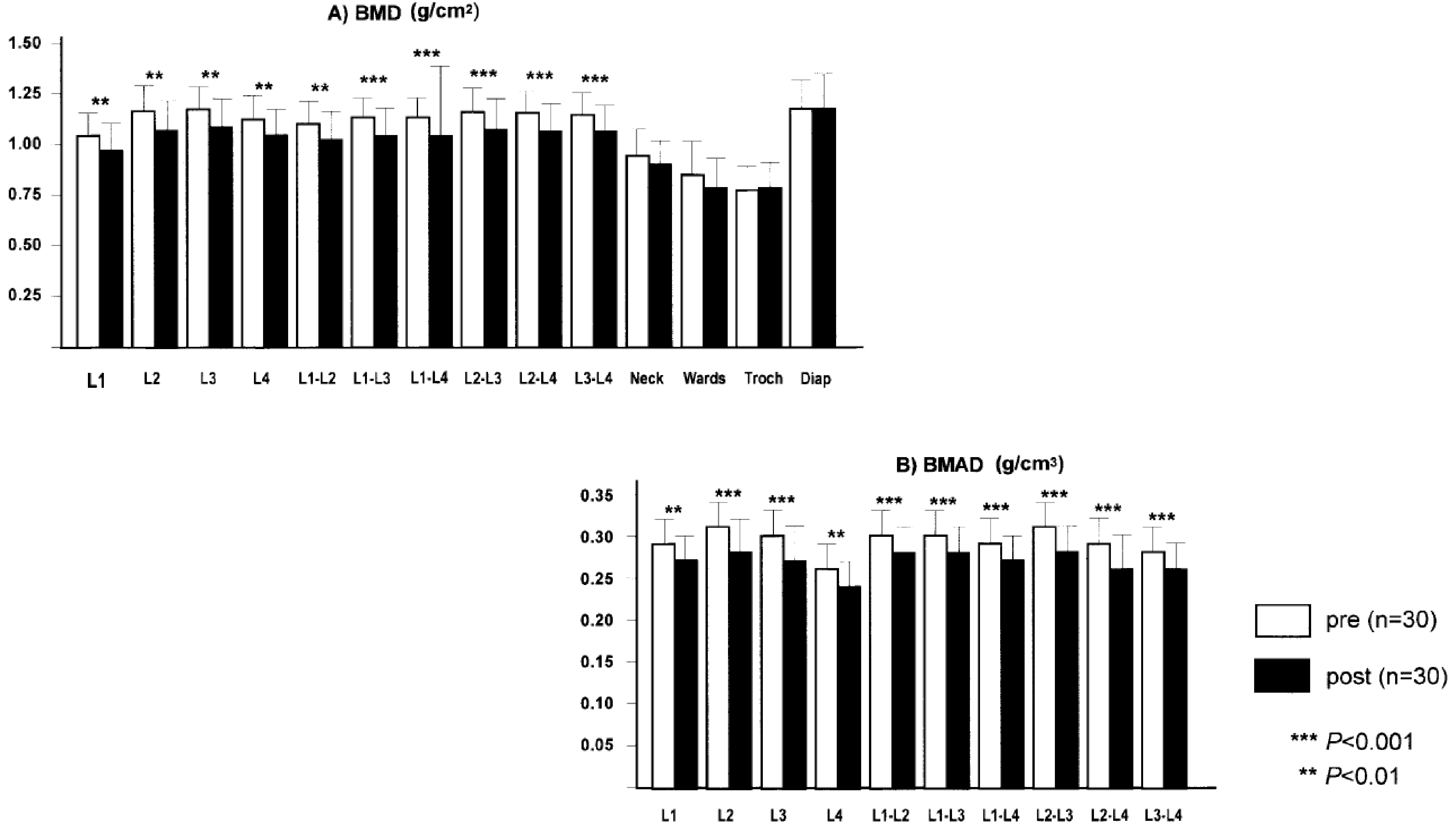


Fig. 1. A) BMD at the spine [lumbar (L) vertebrea] and hip (femur neck, Ward's triangle, trochanter, Troch, and cortical diaphysis, Diap), B), BM(A)D at the spine of pre- (n = 30) and postmenopausal women (n = 30). Mean ± SD ***$p < 0.001$ **$p < 0.01$.

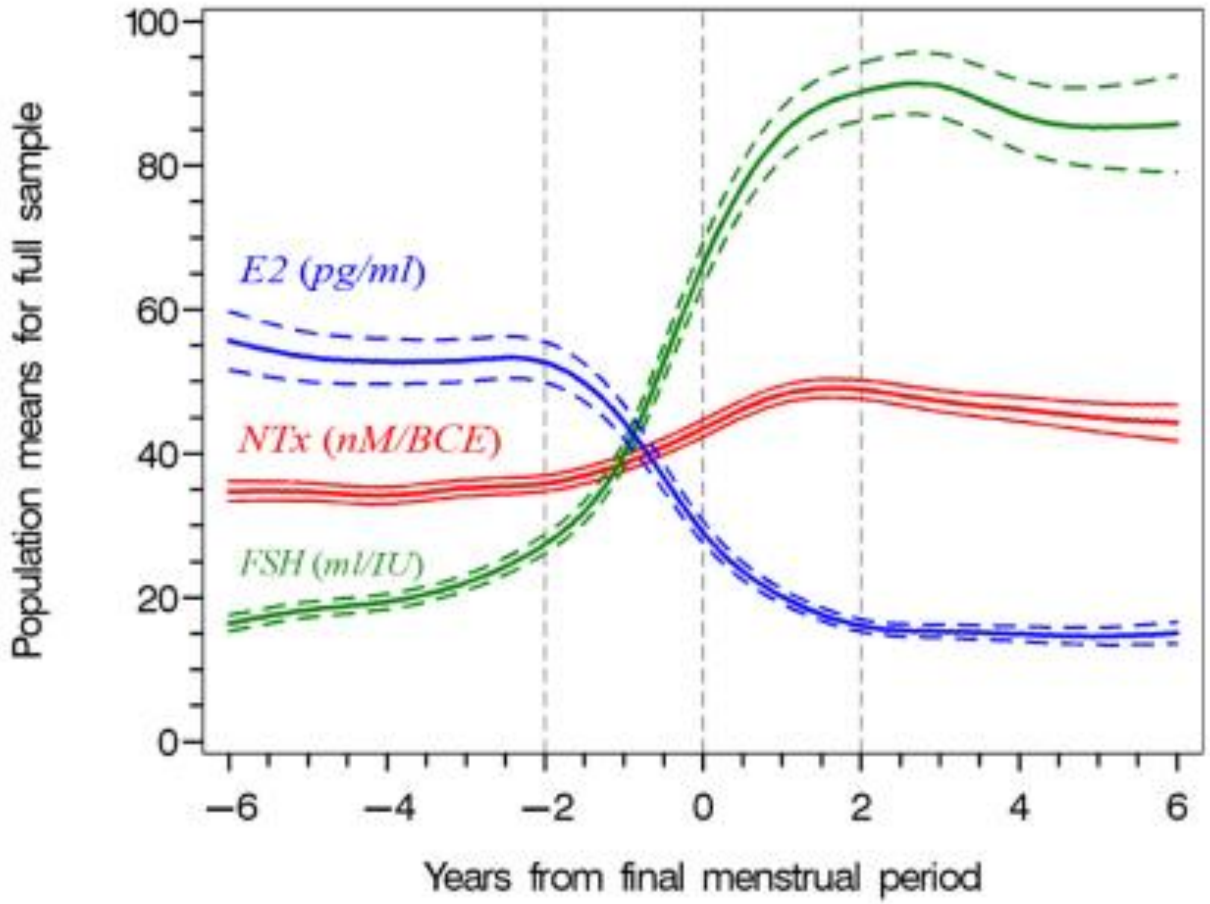
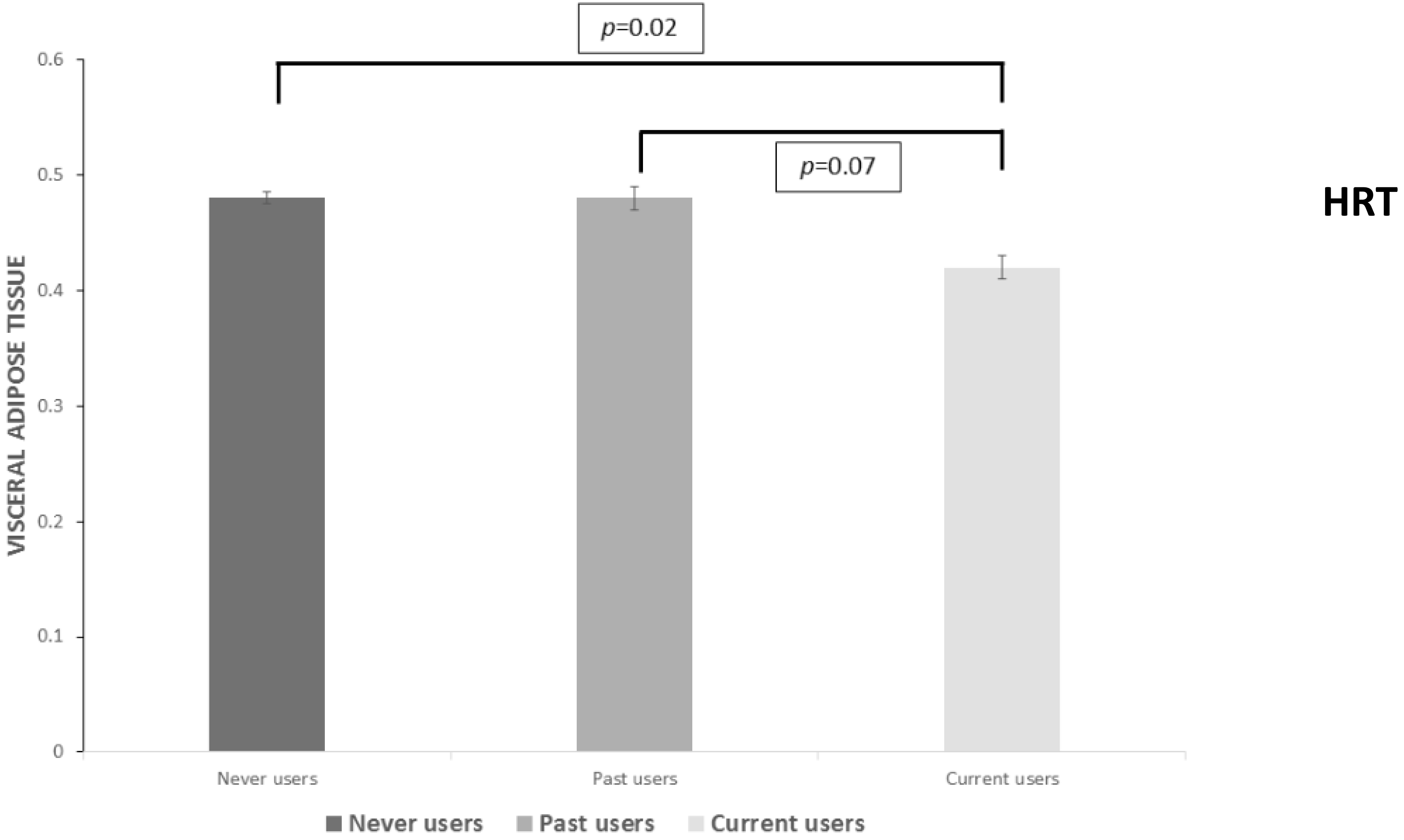


Figure 2. Population mean urine NTX, serum estradiol, and serum FSH levels in relation to years from FMP in the women who experienced a natural FMP (n = 918). The dashed lines denote the 95% confidence intervals.

SUPPLEMENTARY FIGURE 1: Age-adjusted values of visceral adipose tissue stratified by menopausal hormone therapy status.



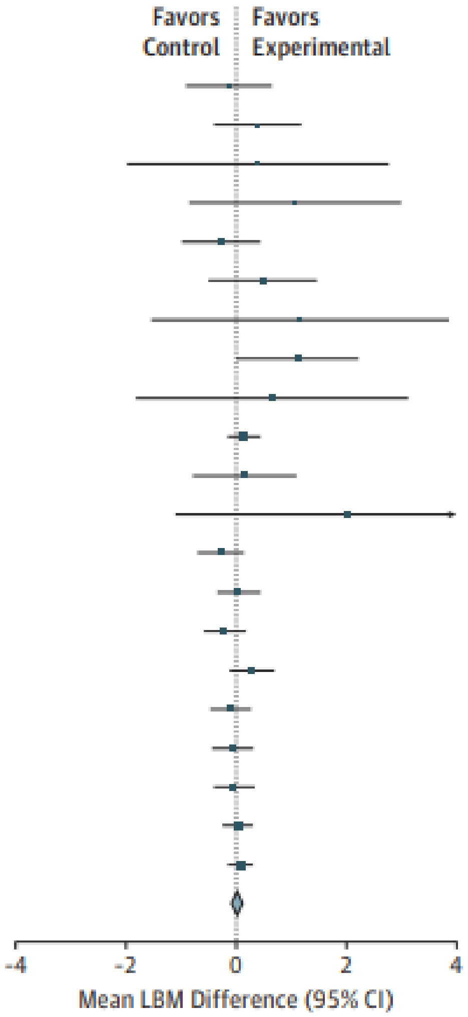
HRT

Figure 2. Summary Meta-analysis of the Association Between Hormone Therapy (HT) Intervention and Muscle Mass Outcomes

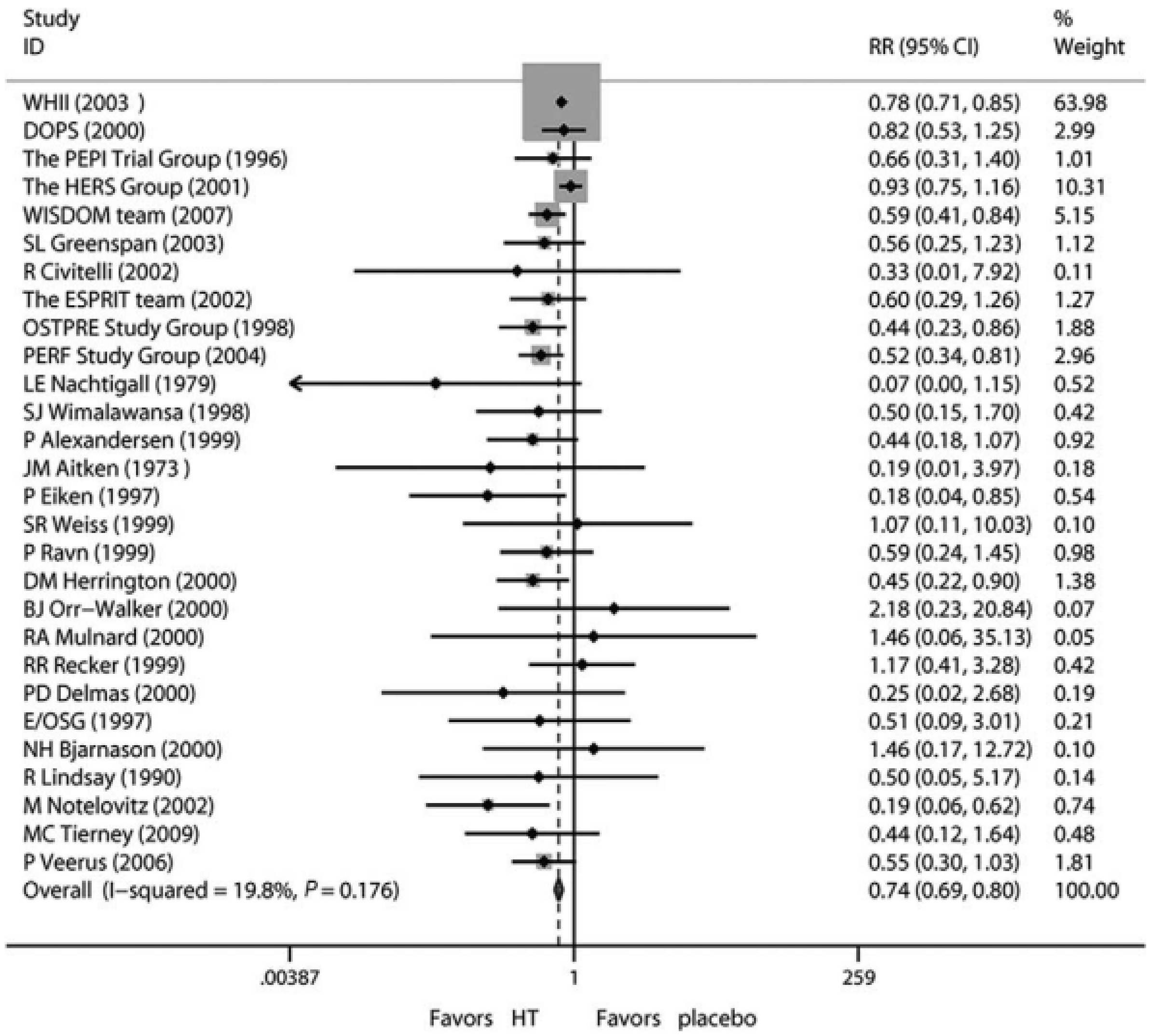
Study	Receiving HT: Mean (SD) LBM Difference, kg	Receiving HT: Total	No HT: Mean (SD) LBM Difference, kg	No HT: Total	Mean LBM Difference (95% CI)
Hassager and Christiansen,[58] 1989	(1) 0.19 (2.15)	32	0.33 (2.13)	58	-0.14 (-1.06 to 0.78)
Hassager and Christiansen,[58] 1989	(2) 0.81 (1.65)	20	0.33 (2.13)	58	0.48 (-0.43 to 1.39)
Haarbo et al,[48] 1991	(1) -0.20 (5.20)	19	-0.70 (3.85)	24	0.50 (-2.30 to 3.30)
Haarbo et al,[48] 1991	(2) 0.60 (3.70)	19	-0.70 (3.85)	24	1.30 (-1.00 to 3.60)
Aloia et al,[60] 1995	-1.06 (1.64)	30	-0.75 (1.59)	28	-0.31 (-1.14 to 0.52)
Evans et al,[61] 2001	1.10 (1.90)	15	0.50 (1.40)	19	0.60 (-0.55 to 1.75)
Sipilä et al,[52] 2001	1.10 (4.25)	15	-0.30 (4.65)	15	1.40 (-1.79 to 4.59)
Sørensen et al,[59] 2001	0.35 (0.86)	7	-1.00 (1.58)	7	1.34 (0.01 to 2.67)
Blackman et al,[47] 2002	1.20 (4.58)	19	0.40 (3.93)	14	0.80 (-2.11 to 3.71)
Jensen et al,[49] 2003	0.18 (1.77)	268	-0.02 (2.33)	353	0.20 (-0.12 to 0.52)
Kenny et al,[50] 2005	-0.30 (3.37)	71	-0.50 (3.30)	68	0.20 (-0.91 to 1.31)
Pöllänen et al,[51] 2007	1.00 (4.00)	10	-1.40 (3.10)	5	2.40 (-1.28 to 6.08)
Thorneycroft et al,[53] 2007	(1A) -0.12 (1.87)	97	0.19 (1.55)	94	-0.31 (-0.80 to 0.18)
Thorneycroft et al,[53] 2007	(1B) 0.26 (1.56)	95	0.19 (1.55)	94	0.07 (-0.37 to 0.51)
Thorneycroft et al,[53] 2007	(1C) -0.04 (1.51)	89	0.19 (1.55)	94	-0.23 (-0.67 to 0.21)
Thorneycroft et al,[53] 2007	(2A) 0.55 (1.48)	86	0.19 (1.55)	94	0.36 (-0.08 to 0.80)
Thorneycroft et al,[53] 2007	(2B) 0.10 (1.47)	96	0.19 (1.55)	94	-0.09 (-0.52 to 0.34)
Thorneycroft et al,[53] 2007	(2C) 0.13 (1.45)	94	0.19 (1.55)	94	-0.06 (-0.49 to 0.37)
Thorneycroft et al,[53] 2007	(2D) 0.16 (1.39)	98	0.19 (1.55)	94	-0.03 (-0.45 to 0.39)
Bea et al,[46] 2011	(1) -0.44 (2.28)	453	-0.50 (2.45)	474	0.06 (-0.24 to 0.36)
Bea et al,[46] 2011	(2) -0.29 (1.99)	543	-0.40 (2.15)	471	0.11 (-0.15 to 0.37)
Total		2176		2276	0.06 (-0.05 to 0.18)

Heterogeneity $\chi^2 = 17.37$; df = 20 ($P = .63$); $I^2 = 0\%$

Test for overall effect $Z = 1.12$ ($P = .26$)



HRT



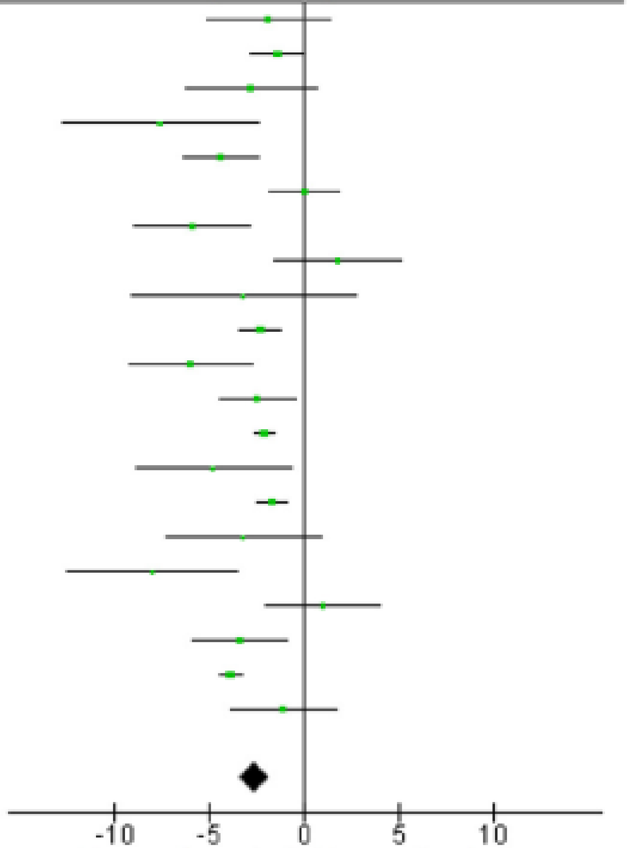
G. 2. Forest plot of the association between HT and total fractures. ID, study ID; HT, hormone therapy; RR, relative risk.

Study or Subgroup	Exercise Training Mean	Exercise Training SD	Exercise Training Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Random, 95% CI
Azadpour 2017	-1.4	4.4	12	0.5	3.66	12	3.5%	-1.90 [-5.14, 1.34]
Bergström 2009	-1.6	3.61	48	-0.2	3.35	44	7.1%	-1.40 [-2.82, 0.02]
Biteli 2021a	-3.5	5.9	24	-0.7	6.23	22	3.2%	-2.80 [-6.31, 0.71]
Biteli 2021b	-7.3	6.71	11	0.3	6.21	13	1.8%	-7.60 [-12.81, -2.39]
Chagas 2017	-4.7	0.92	35	-0.3	5.85	35	5.9%	-4.40 [-6.36, -2.44]
Church 2007	-1.4	6.42	103	-1.4	6.59	102	6.3%	0.00 [-1.78, 1.78]
Colado 2009	-3.6	4.19	21	2.3	4.08	10	3.7%	-5.90 [-9.00, -2.80]
Conceicao 2013	1.5	2	10	-0.3	5.02	10	3.4%	1.80 [-1.55, 5.15]
Dalleck 2009	-2.5	6.99	8	0.7	5.58	10	1.4%	-3.20 [-9.15, 2.75]
Friedenreich 2011	-2.2	4.8	160	0.1	5.12	160	8.0%	-2.30 [-3.39, -1.21]
Gomez-Tomas 2018	-2.7	4.5	18	3.3	5.81	20	3.5%	-6.00 [-9.29, -2.71]
Hettchen 2021	-2.9	3.9	27	-0.4	3.6	27	5.8%	-2.50 [-4.50, -0.50]
Kim and Kim 2012	-1.2	0.72	15	0.9	0.84	15	9.0%	-2.10 [-2.66, -1.54]
Latosik 2014	-3.8	5.77	15	1	4.65	10	2.6%	-4.80 [-8.90, -0.70]
Lee 2012	-1.3	0.72	8	0.4	0.96	8	8.5%	-1.70 [-2.53, -0.87]
Lesser 2016	-4	7.37	23	-0.8	7.34	26	2.5%	-3.20 [-7.33, 0.93]
Nunes 2016	-4	5.44	11	4	5.31	11	2.2%	-8.00 [-12.49, -3.51]
Senechal 2012	-0.7	4.9	10	-1.7	0.3	10	3.8%	1.00 [-2.04, 4.04]
Seo 2010	-4.3	2.58	8	-0.9	2.38	7	4.7%	-3.40 [-5.91, -0.89]
Son and Park 2021	-3.4	0.3	18	0.5	1.1	17	9.0%	-3.90 [-4.44, -3.36]
Trabka 2014	-1	4.82	23	0.1	4.71	21	4.2%	-1.10 [-3.92, 1.72]
Total (95% CI)			**608**			**590**	**100.0%**	**-2.62 [-3.39, -1.86]**

Heterogeneity: $Tau^2 = 1.62$; $Chi^2 = 76.49$, df = 20 ($P < 0.00001$); $I^2 = 74\%$

Test for overall effect: $Z = 6.70$ ($P < 0.00001$)

Mean Difference IV, Random, 95% CI



Exercise

Fig. 2. Forest plot of randomised controls trials investigating the effect of exercise training vs control on waist circumference using the random effects model. There are a total of 21 studies reporting changes in waist circumference (cm). Negative values favour exercise intervention on the left side. 95% CI: 95% confidence interval; MD: mean difference; SD: standard deviation.

Meta-analyses

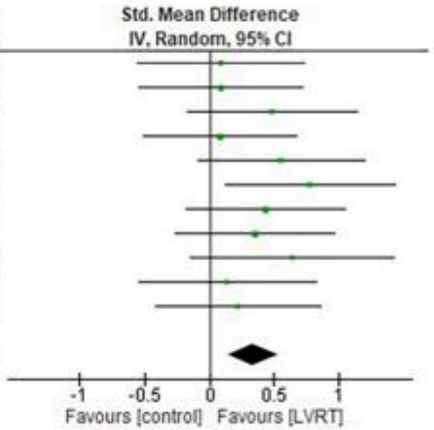
Effects of exercise training on metabolic syndrome risk factors in post-menopausal women – A systematic review and meta-analysis of randomised controlled trials

Abbigail Tan [a,*], Rebecca L. Thomas [b], Matthew D. Campbell [c,d], Sarah L. Prior [b], Richard M. Bracken [a], Rachel Churm [a]

[a] Applied Sports Technology, Exercise and Medicine (A-STEM) Research Centre, Faculty of Science and Engineering, Swansea University, Swansea, UK
[b] Diabetes Research Group, Grove Building, Swansea University, Swansea, UK
[c] School of Nursing and Health Sciences, Sciences Complex, University of Sunderland, Sunderland, UK
[d] Leeds Institute of Cardiovascular and Metabolic Medicine, University of Leeds, Leeds, UK

Study or Subgroup	LVRT Mean	LVRT SD	LVRT Total	Control Mean	Control SD	Control Total	Weight	Std. Mean Difference IV, Random, 95% CI
Cavalcante et al., 2018 (1)	0.3	5.5	18	-0.2	5	19	9.1%	0.09 [-0.55, 0.74]
Cavalcante et al., 2018 (2)	0.3	6	20	-0.2	5	19	9.6%	0.09 [-0.54, 0.72]
Cunha et al., 2021 (1)	0.95	1.32	19	0.15	1.870962	18	8.8%	0.49 [-0.17, 1.14]
Do Nascimento et al., 2018	0.61	4	22	0.27	4.12871	22	10.9%	0.08 [-0.51, 0.67]
Dos Santos et al., 2020 (1)	0.7	2.4	20	-0.9	3.206244	19	9.2%	0.56 [-0.09, 1.20]
Dos Santos et al., 2020 (2)	1.3	2.28	20	-0.9	3.206244	19	8.9%	0.78 [0.12, 1.43]
Fritz et al., 2018 (1)	0.69	2.27	22	-0.19	1.592545	20	10.1%	0.44 [-0.18, 1.05]
Fritz et al., 2018 (2)	0.44	1.87	21	-0.19	1.592545	20	9.9%	0.35 [-0.26, 0.97]
Gambassi et al., 2016	4	5.2	13	0	6.811755	13	6.1%	0.64 [-0.15, 1.43]
Ribeiro et al., 2020	0.5	3.96	18	-0.1	4.450281	15	8.1%	0.14 [-0.55, 0.83]
Tomeleri et al., 2016	0.7	1.95	19	0.2	2.5	19	9.3%	0.22 [-0.42, 0.86]
Total (95% CI)			**212**			**203**	**100.0%**	**0.34 [0.14, 0.53]**

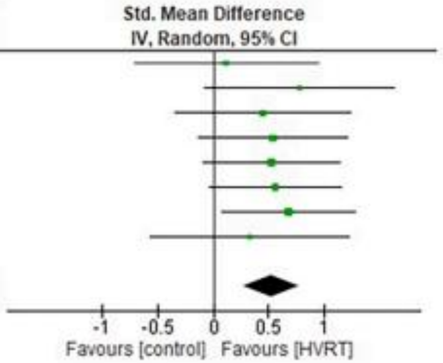
Heterogeneity: Tau² = 0.00; Chi² = 5.37, df = 10 (P = 0.87); I² = 0%
Test for overall effect: Z = 3.41 (P = 0.0007)



A

Study or Subgroup	HVRT Mean	HVRT SD	HVRT Total	Control Mean	Control SD	Control Total	Weight	Std. Mean Difference IV, Random, 95% CI
Bouchard et al., 2009	0.2	4.2	11	-0.3	4.3	12	9.1%	0.11 [-0.71, 0.93]
Coelho-Júnior et al., 2019 (1)	2.4	2.47	10	-0.3	3.88	14	8.5%	0.77 [-0.07, 1.62]
Coelho-Júnior et al., 2019 (2)	1.5	3.9	12	-0.3	3.88	14	10.0%	0.45 [-0.33, 1.23]
Cunha et al., 2021 (2)	1.17	1.83	18	0.15	1.87	18	13.8%	0.54 [-0.13, 1.21]
Orsatti et al., 2008	1.8	3.45	21	0.2	2.5	22	16.5%	0.52 [-0.09, 1.13]
Tomeleri et al., 2018a	1.1	2.35	24	-0.2	2.2	22	17.5%	0.56 [-0.03, 1.15]
Tomeleri et al., 2018b	1	1.9	22	-0.4	2.16	23	16.8%	0.68 [0.07, 1.28]
Urzi et al., 2019	0.2	2.18	11	-0.5	1.86	9	7.7%	0.33 [-0.56, 1.22]
Total (95% CI)			**129**			**134**	**100.0%**	**0.52 [0.27, 0.77]**

Heterogeneity: Tau² = 0.00; Chi² = 1.78, df = 7 (P = 0.97); I² = 0%
Test for overall effect: Z = 4.11 (P < 0.0001)



B

Fig. 3. Forest plot of the effects of resistance training volume on muscle hypertrophy. A - Low volume resistance training (LVRT) vs Control and B - High volume resistance training (HVRT) vs Control.

Archives of Gerontology and Geriatrics 124 (2024) 105474

Exercise

Exercise

IVhet Analysis of Change of Bone Mineral Density of Hip

Study	EG Mean	EG SD	CG Mean	CG SD	SMD (95%CI)
Bello (2014)	0.000	0.042	0.090	0.333	-0.36 [-1.25, 0.52]
Bemben (2010)	-0.003	0.014	-0.002	0.010	-0.08 [-0.78, 0.63]
Bemben (2000HL)	-0.002	0.035	-0.006	0.031	0.11 [-0.95, 1.17]
Bemben (2000HR)	0.003	0.035	-0.006	0.031	0.25 [-0.72, 1.22]
Bergström (2008)	0.005	0.018	-0.003	0.019	0.43 [0.05, 0.81]
Bolton (2012)	0.004	0.012	-0.007	0.014	0.82 [0.17, 1.48]
Chilibeck (2013)	-0.005	0.024	-0.013	0.026	0.32 [0.02, 0.62]
Chilibeck (2002)	-0.002	0.021	-0.006	0.021	0.19 [-0.56, 0.93]
Choquette (2011)	0.000	0.028	0.000	0.016	0.00 [-0.55, 0.55]
De Matos (2009)	-0.006	0.032	-0.005	0.031	-0.03 [-0.54, 0.48]
De Oliveira (2018)	0.020	0.030	0.000	0.010	0.87 [0.17, 1.58]
Duff (2016)	0.008	0.031	0.001	0.024	0.25 [-0.35, 0.84]
Hans (2002)	0.005	0.018	-0.004	0.016	0.52 [0.14, 0.91]
Hettchen (2021)	-0.001	0.016	-0.009	0.020	0.44 [-0.10, 0.98]
Kemmler (2013)	-0.003	0.012	-0.007	0.012	0.33 [-0.10, 0.76]
Kemmler (2004)	-0.002	0.014	-0.014	0.015	0.83 [0.47, 1.19]
Kerr (2001F)	-0.006	0.024	-0.006	0.031	0.00 [-0.52, 0.52]
Kerr (2001S)	0.011	0.026	-0.006	0.031	0.61 [0.07, 1.14]
Maddalozzo (2006)	-0.004	0.025	-0.023	0.020	0.82 [0.33, 1.31]
Marques, Wand (2011RE)	0.014	0.029	-0.007	0.023	0.76 [0.04, 1.48]
Marques, Wand (2011AE)	0.001	0.027	-0.007	0.023	0.30 [-0.39, 1.00]
Nicholson (2015)	-0.002	0.022	-0.028	0.034	0.90 [0.35, 1.44]
Prince (1995)	0.004	0.026	-0.012	0.021	0.66 [0.22, 1.10]
Pruitt (1995HI)	0.005	0.014	0.007	0.010	-0.15 [-1.09, 0.80]
Pruitt (1995LI)	0.008	0.012	0.007	0.010	0.08 [-0.88, 1.05]
Sakai (2010)	-0.001	0.026	-0.004	0.020	0.13 [-0.28, 0.53]
Sugiyama (2002)	0.006	0.024	-0.003	0.015	0.43 [-0.35, 1.21]
Waltman (2022)	0.010	0.022	0.004	0.014	0.33 [0.04, 0.62]
Woo (2007RE)	0.000	0.024	-0.016	0.020	0.69 [0.05, 1.32]
Woo (2007TC)	0.000	0.020	-0.016	0.020	0.79 [0.15, 1.43]
Wu (2006)	-0.005	0.025	-0.012	0.026	0.27 [-0.20, 0.75]
IVhet Model for All Studies ($Q = 37.28$, $df = 30$, $p = 0.169$; $I^2 = 19.5\%$)					0.41 [0.30, 0.52]

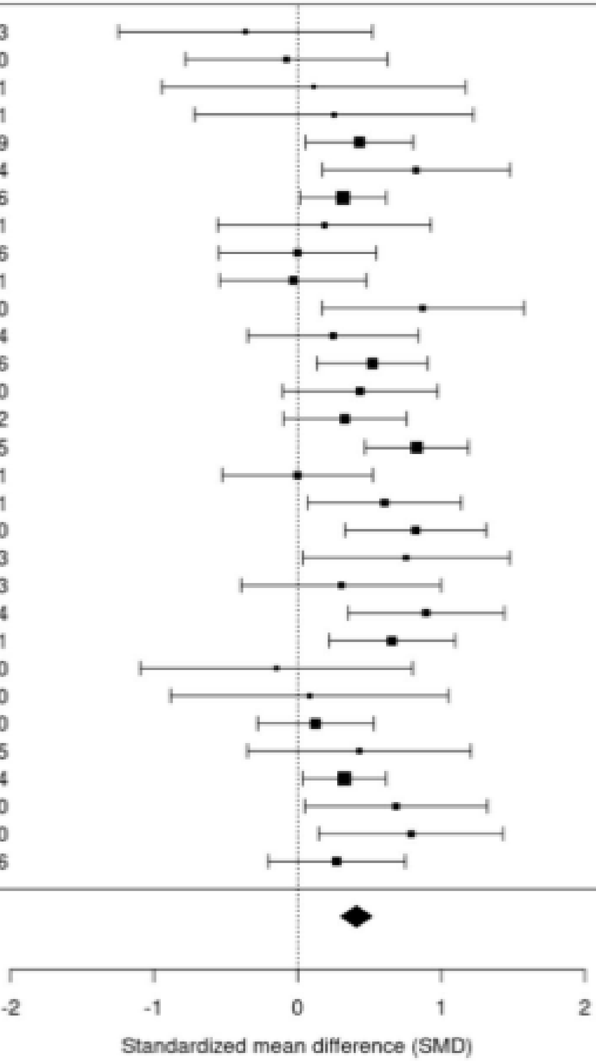
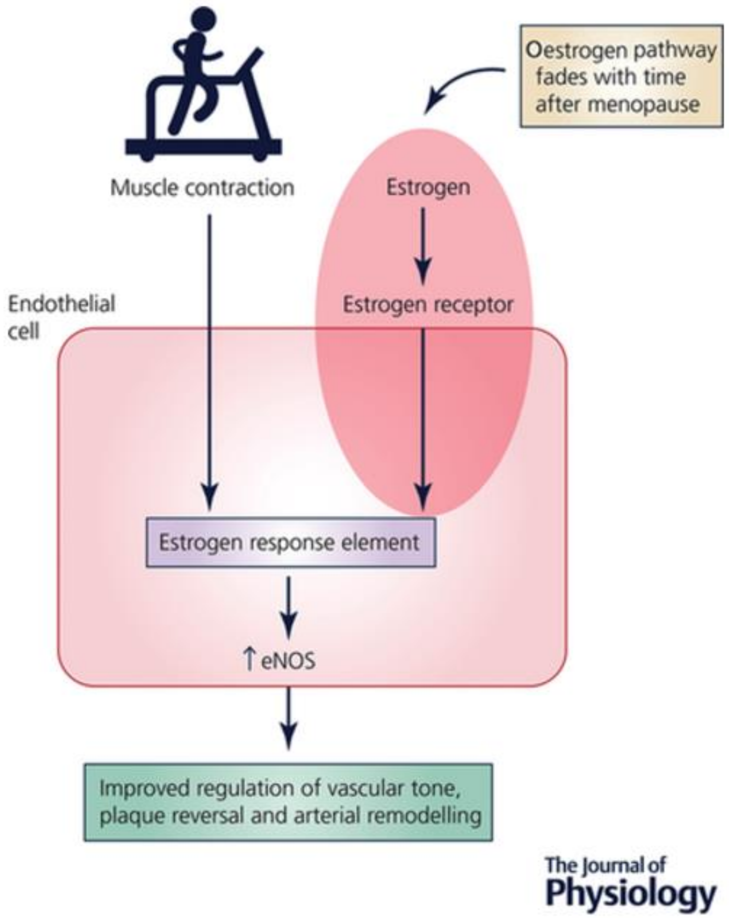
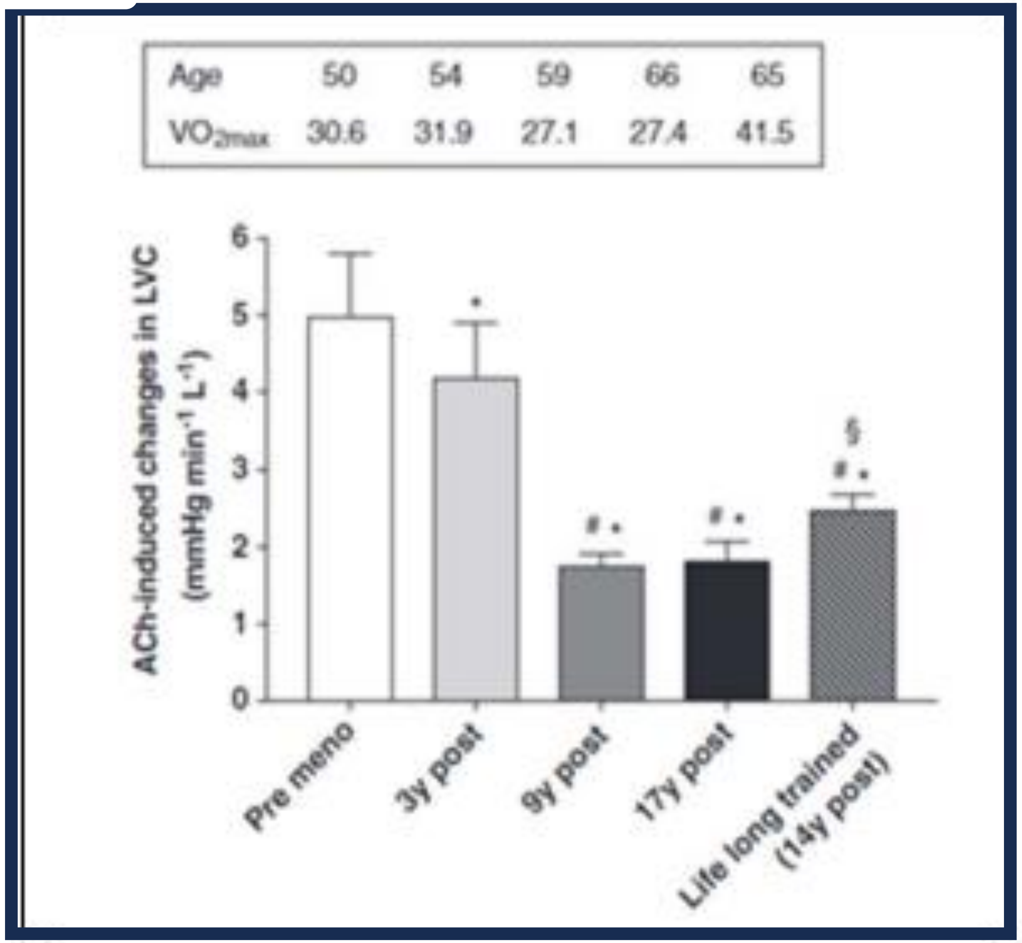


Fig. 6 Forest plot of meta-analysis results at the total hip (IVhet model). The data are shown as pooled standard mean difference (SMD) with 95% CI for changes in the exercise (EG) versus control groups (CG). Imputation with mean correlation

Timing hypothesis





Glieman
&
Hellsten (2017)

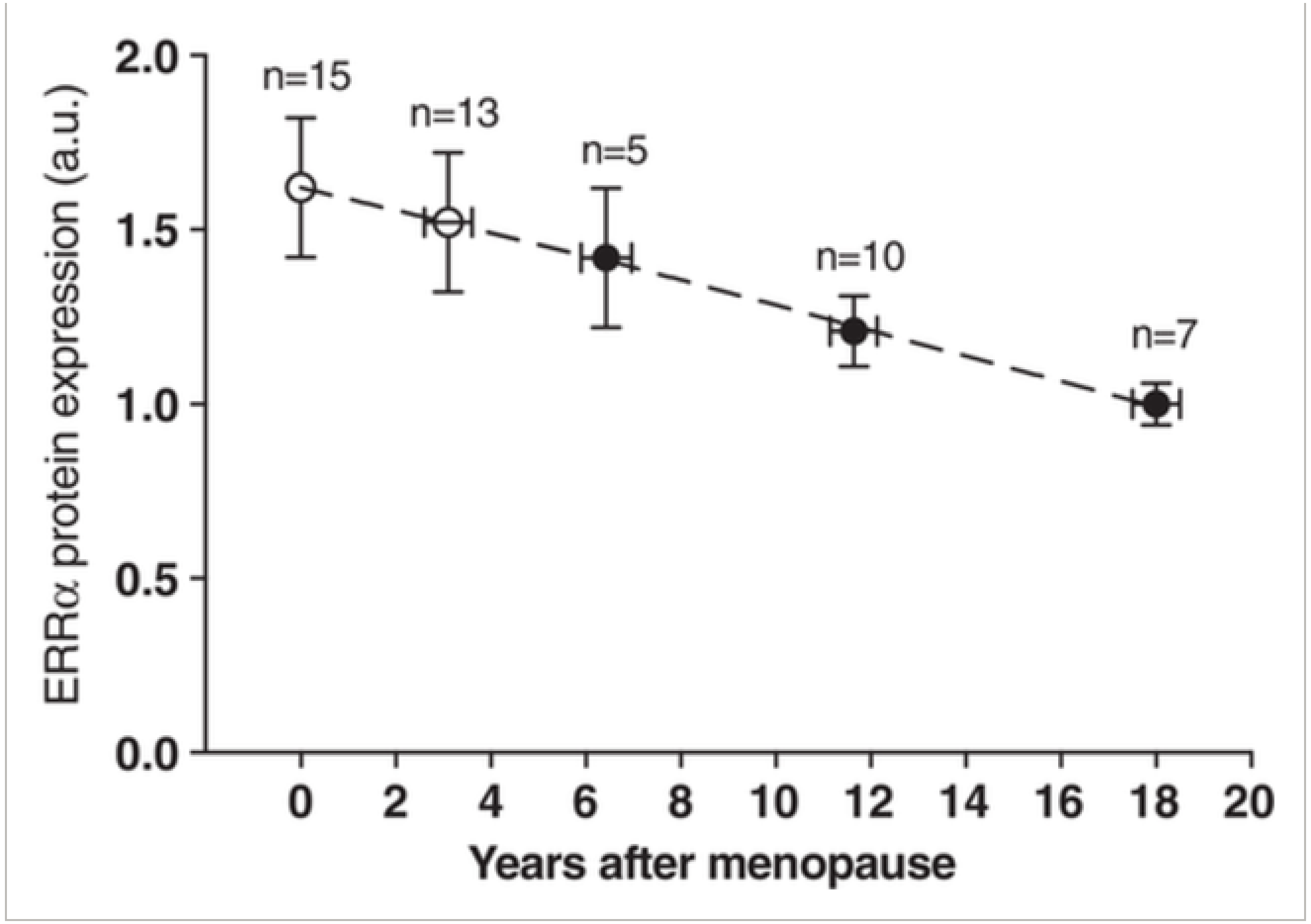


Figure 3. Protein expression of oestrogen-related receptor α (ERRα) as a function of time after menopause in skeletal muscle homogenates from sedentary pre- and postmenopausal women

Table 4. Body Composition Changes in Exercisers and Nonexercisers

Variable	EX/HRT (n = 16)	NEX/HRT (n = 22)	EX/NHRT (n = 20)	NEX/NHRT (n = 26)
LST mass				
Total body (kg)	0.6 ± 0.3	0.2 ± 0.4	0.7 ± 0.2*	−0.4 ± 0.2
Arm (kg)	0.2 ± 0.1**	0.1 ± 0.1	0.2 ± 0.1*	0.0 ± 0.0
Leg (kg)	0.1 ± 0.1***	−0.2 ± 0.1	0.1 ± 0.1*	−0.2 ± 0.1
Fat mass				
Total body (kg)	−0.9 ± 0.7	0.1 ± 0.8	−0.6 ± 0.5	1.0 ± 0.7
Arm (kg)	−0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.7	0.2 ± 0.1
Leg (kg)	−0.7 ± 0.2***	−0.0 ± 0.2	−0.3 ± 0.2	0.2 ± 0.2
Trunk (kg)	−0.2 ± 0.2	−0.0 ± 0.3	−0.4 ± 0.3**	0.6 ± 0.4
Body fat (%)	−1.4 ± 0.8	0.0 ± 0.7	−0.9 ± 0.5*	1.0 ± 0.4

Notes: Body composition changes are from baseline to 12 months, within hormone replacement therapy (HRT) and no hormone replacement therapy (NHRT) groups. EX = exercise; NEX = no exercise; LST= lean soft tissue. Values are mean ± *SEM*. Multiple linear regression with a priori contrasts (HRT vs NHRT, EX/HRT vs NEX/HRT, and EX/NHRT vs NEX/NHRT) was used to determine differences between groups.

*$p < .05$; **$p = .08$; ***$p = .09$.

	Estrogen ($n = 15$)					Placebo ($n = 16$)						
	Pre		Post		*P*-value	Pre		Post		*P*-value	Training	Interaction
MVIC Ext (NM)	143	± 23.2	161.6	± 30.2	**<0.01**	135.2	± 38.8	158.4	± 39.0	**<0.01**	**<0.01**	0.43
MVIC Flx (NM)	70.0	± 13.8	76.9	± 16.5	**0.03**	66.6	± 20.5	78.8	± 23.2	**<0.01**	**0.03**	0.19
5 RM leg press (kg)	83.8	± 13.6	132.2	± 19.8	**<0.01**	89.1	± 25.4	131.8	± 29.5	**<0.01**	**<0.01**	0.23
5 RM knee Ext (kg)	40.3	± 10.0	57.8	± 11.0	**<0.01**	44.1	± 8.7	59.4	± 11.2	**<0.01**	**<0.01**	0.31
5 RM knee Flx (kg)	18.6	± 3.8	26.9	± 4.8	**<0.01**	20.6	± 4.0	28.4	± 6.4	**<0.01**	**<0.01**	0.26

Values are presented at mean ± SD. MVIC Ext, maximal voluntary isometric contraction in knee extension; MVIC Flx, maximal voluntary isometric contraction in knee flexion; 5 RM, five-repetition maximum. P-values relates to pre vs. post changes within each group and results from Linear mixed model analysis on training effect and training x treatment interaction effects. P-values at 0.05 or below are reported in bold.

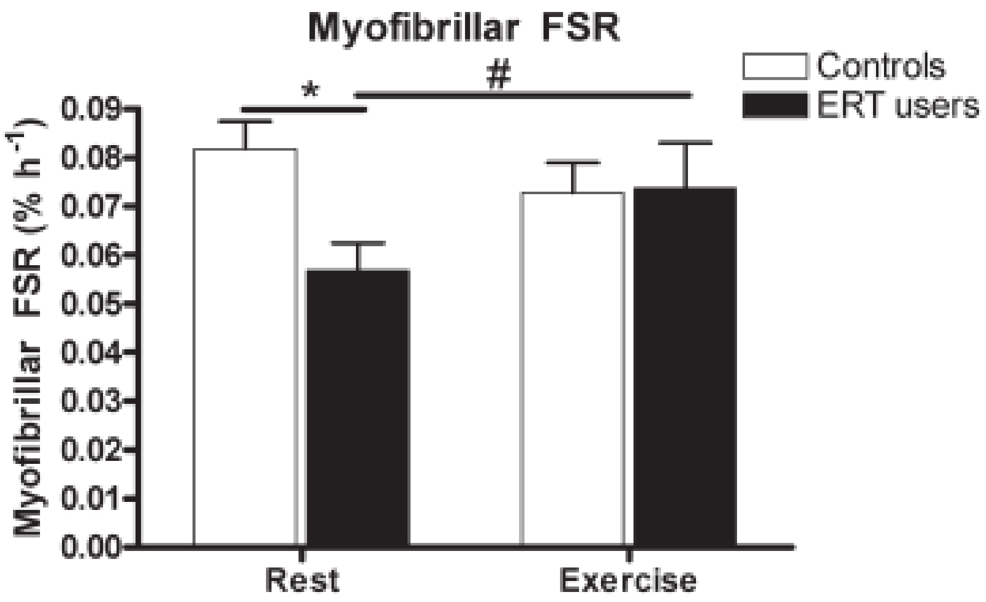


Figure 2. Myofibrillar protein fractional synthesis rate at rest and 24 hours after exercise in women, who use estrogen replacement therapy (ERT), and in women, who do not use ERT (Controls). Values are means ± standard error of the mean. Two-way analysis of variance with repeated measures in one factor: ERT users versus Controls, $p = .18$; rest versus exercise, $p = .34$; and interaction between rest or exercise and Controls or ERT, $p = .005$. *$p = .015$ ERT versus Controls. #$p = .010$ ERT_{rest} versus $ERT_{exercise}$.

Zijn er nog vragen??