Electronic Supplementary Material (ESI) for Food & Function.

Supplementary information

Table S1: Risk of bias assessment in the included studies

Study	Other bias	Selective reporting	Incomplete outcome data	Blinding of outcome assessment	Blinding of participants /personnel	Allocation concealment	Random sequence generator
Agin 2001	L	L	L	U	U	L	L
Agin 2000	L	L	L	U	U	U	L
Arazi 2011	L	L	L	L	L	U	L
Arnarson 2013	L	L	L	L	L	U	L
Bemben 2009	L	L	L	L	L	U	L
Burke 2001	L	L	L	L	L	L	L
Candow 2006	L	L	L	L	L	U	L
Chale 2012	L	L	L	L	L	U	L
DeNysschen 2009	L	L	L	L	L	U	L
Eliot 2008	L	L	L	L	L	U	L
Englund 2017	L	L	L	L	L	U	L
Erskine 2012	L	L	L	L	L	U	L
Lockwood 2016	L	L	L	L	L	U	L
Mobley 2017	L	L	L	L	L	U	L
Naclerio 2017a	L	L	L	L	L	U	L
Naclerio 2017b	L	L	L	L	L	U	L
Reidy 2016	L	L	L	L	L	U	L
Sugihara 2017	L	L	L	L	L	U	L
Taylor 2015	L	L	L	L	L	U	L
Volek 2013	L	L	L	L	L	U	L
Weisgarber 2012	L	L	L	L	L	U	L
Weisgarber 2015	L	L	L	L	L	U	L

Legends: H: high risk; L: low risk; U: unclear risk

Table S2: Important characteristics of the included studies													
Study	nW	nC	Subjects	RT duration (weeks)	Design	% males	Age (years)	Height (cm)	Weight (kg)	BMI (kg/m^2)	Baseline lean mass (kg)		Baseline fat mass (kg)	
											Whey	**Placebo**	**Whey**	**Placebo**
Agin 2001	10	10	Women with HIV	14	RCT	0	42±10.4	160±6.5	57±8	24±2.4	38.8±6.3	40.2±2.7	15.8±4.4	18.4±5.1
Arazi 2011	20	20	Novice men	8	DB-RCT	100	22±2.3	174.5±39	73.2±6.2					
Arnarson 2013	75	66	Elderly	12	DB-RCT	42	74±6	169±9.4	82.4±18	28.6±4.6				
Bemben 2009	11	10	Elderly men	14	DB-RCT	100	57±1.7	177.5±1.9	93±6.2	88.3±4.4				
Burke 2001	10	5	University males	12	DB-RCT	100					62.3±2.6	61.8±4	13.9±1.6	9.5±2.2
Candow 2006	9	9	Young adults	6	DB-RCT	33	23.5±7	170.6±18	69.3±12		45±1.7	45.1±1.6		
Chale 2012	42	38	Mobility limited elderly	24	DB-RCT	100	77.7±4	165±8.3	73.4±11	27±3	73.5±11	73.7±11	25.9±6.9	25.6±7.2
DeNysschen 2009	10	9	Hyperlipidemic adults	12	DB-RCT	100	38±7.3		90±4	28.2±.5	68.9±2.8	69.2±2.5	21±1.9	20.6±1.2
Eliot 2008	11	10	Healthy adults	14	DB-RCT	100					64±1.9	68±3.8	21.6±2.5	27.5±1.7
Englund 2017	74	75	Mobility limited elderly	24	DB-RCT	54	77.5±5.5		80±13	28.1±3.7				
Erskine 2012	17	16	Healthy adults	12	DB-RCT	100	23.4±3	176.2±6.5	75.3±11					
Lockwood 2016	13	15	Healthy young men	8	DB-RCT	62	21±2.3	180±5.3	80±7		64.4±3.6	60.4±3.9	16.6±7.2	13.4±7.7
Mobley 2017	17	15	Healthy young men	12	DB-RCT	100	21±4	181±8	80±11.7		59±16.5	58±15.5	19.5±20.6	18.1±12
Naclerio 2017a	8	8	Healthy adults	8	DB-RCT	100	25.5±6.5	179±10	77.5±9		66.1±5.8	62±10.3	11.94±4.1	14.9±11
Naclerio 2017b	9	9	Healthy adults	8	DB-RCT	57	26±6	172±10	70±13					
Reidy 2016	22	23	Healthy young men	12	DB-RCT	100	25±1	177±2	79±2.5	25.2±.7	57.6±1.5	55.2±1.5	20.5±1.3	18.4±1.7
Sugihara 2017	15	16	Older women	12	DB-RCT	0	67.6±4	155.8±5.4	62±7.1	25.5±2.5				
Taylor 2015	8	6	Female basketball players	8	DB-RCT	0	20.5±2.5	170±6	67±5.2		43.2±3.4	42.7±3.1	17.9±4.9	15.9±4.1
Volek 2013	19	19	Healthy adults	36	DB-RCT	68	22.6±3.4	172±8.9	73.2±15					
Weisgarber 2012	9	9	Novice adults	8	DB-RCT	56	24.5±3.1	171.2±8.7	85±16.5		48.8±9.1	43.8±9.4	30.3±7.9	20.7±9
Weisgarber 2015	10	10	Postmenopausal women	10	DB-RCT	0	57±4.7	163±5.5	75±17.4	28.3±7	1.85±.42	1.8±0.34		

Table S3a: Metaregression outcomes of overall population (coefficients [95% CI]; p value)

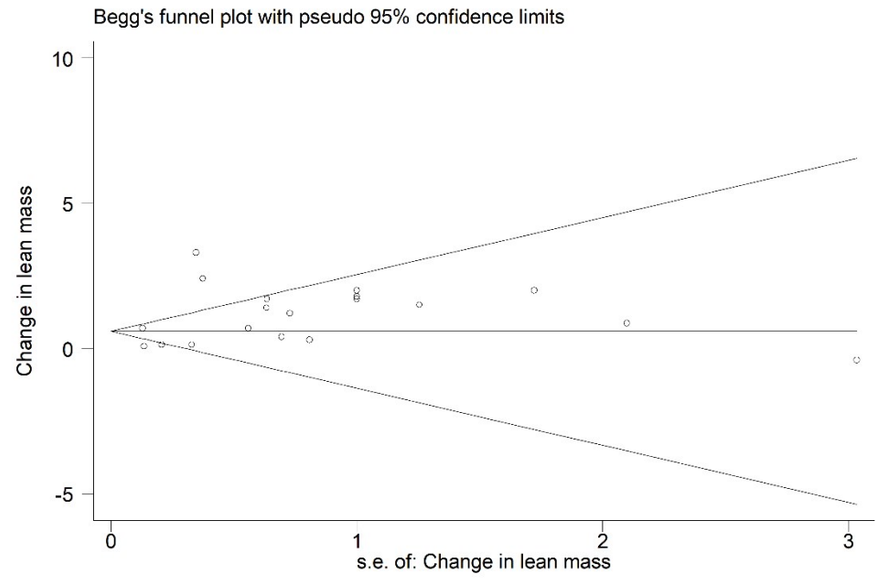
Explanatory variable	WP-RT group	placebo-RT group
Change in lean mass		
Training duration (weeks)	0.016 [−0.048, 0.079]; p=0.601	0.029 [−0.029, 0.087]; p=0.309
Age (years)	**−0.025 [−0.044, −0.007]; p=0.01**	−0.015 [−0.037, 0.006]; p=0.148
Height (cm)	0.042 [−0.060, 0.144]; p=0.385	0.039 [−0.076, 0.155]; p=0.464
Weight (kg)	−0.017 [−0.083, 0.050]; p=0.569	0.015 [−0.063, 0.093]; p=0.679
Baseline lean mass	0.026 [−0.037, 0.076]; p=0.461	0.023 [−0.053, 0.10]; p=0.518
Change in fat mass		
Training duration (weeks)	0.004 [−0.051, 0.059]; p=0.872	−0.029 [−0.095, 0.037]; p=0.359
Age (years)	0.001 [−0.021, 0.022]; p=0.938	−0.018 [−0.045, 0.009]; p=0.174
Height (cm)	−0.021 [−0.102, 0.061]; p=0.592	**0.076 [0.031, 0.120]; p=0.003**
Weight (kg)	**−0.059 [−0.111, −0.008]; p=0.028**	−0.003 [−0.087, 0.082]; p=0.945
Baseline fat mass	−0.028 [−0.120, 0.065]; p=0.526	−0.062 [−0.165, 0.041]; p=0.216

Abbreviations: WP-RT, whey protein with resistance training; placebo-RT, placebo with resistance training.

Table S3b: Metaregression outcomes of healthy individuals (coefficients [95% CI]; p value)

Explanatory variable	Change in lean mass in WP-RT group	Change in lean mass in placebo-RT group
Change in lean mass		
Training duration (weeks)	0.059 [−0.005, 0.124]; p=0.068	0.052 [−0.013, 0.117]; p=0.105
Age (years)	−0.059 [−0.189, 0.070]; p=0.328	0.062 [−0.097, 0.220]; p=0.396
Height (cm)	−0.011 [−0.212, 0.190]; p=0.906	0.105 [−0.112, 0.322]; p=0.298
Weight (kg)	−0.025 [−0.117, 0.0566]; p=0.546	0.090 [−0.027, 0.207]; p=0.115
Baseline lean mass	−0.011 [−0.088, 0.065]; p=0.743	0.032 [−0.084, 0.147]; p=0.552
Change in fat mass		
Training duration (weeks)	0.002 [−0.069, 0.072]; p=0.961	−0.027 [−0.109, 0.055]; p=0.489
Age (years)	**−0.077 [−0.154, 0.0001]; p=0.050**	**−0.160 [−0.200, 0.119]; p<0.00001**
Height (cm)	0.056 [−0.095, 0.207]; p=0.424	**0.080 [0.016, 0.144]; p=0.020**
Weight (kg)	−0.057 [−0.141, 0.026]; p=0.159	−0.066 [−0.174, 0.042]; p=0.207
Baseline fat mass	−0.072 [−0.231, 0.087]; p=0.337	−0.046 [−0.135, 0.042]; p=0.263

Abbreviations: WP-RT, whey protein with resistance training; placebo-RT, placebo with resistance training.



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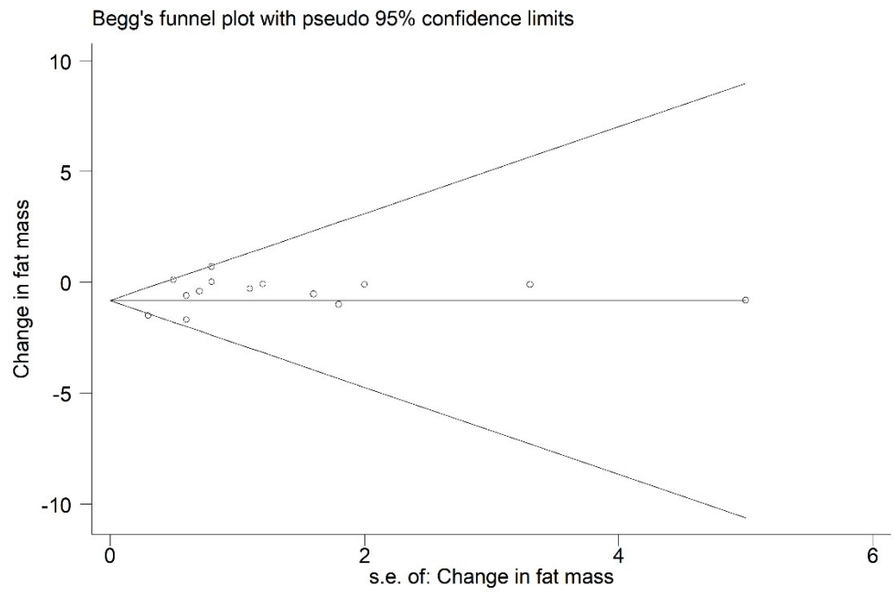

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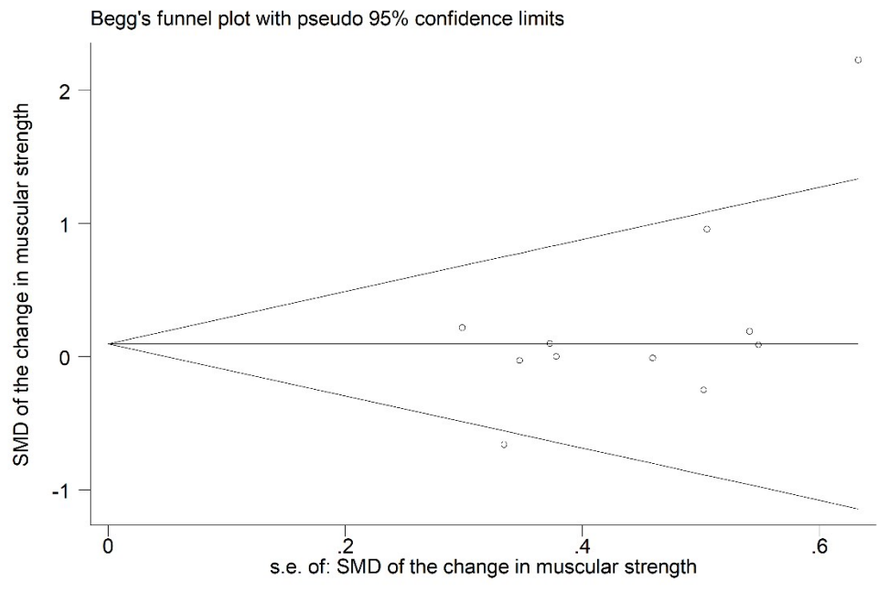

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Figure S1: A funnel plots showing the outcomes of Begg's test for the assessment of publication bias.

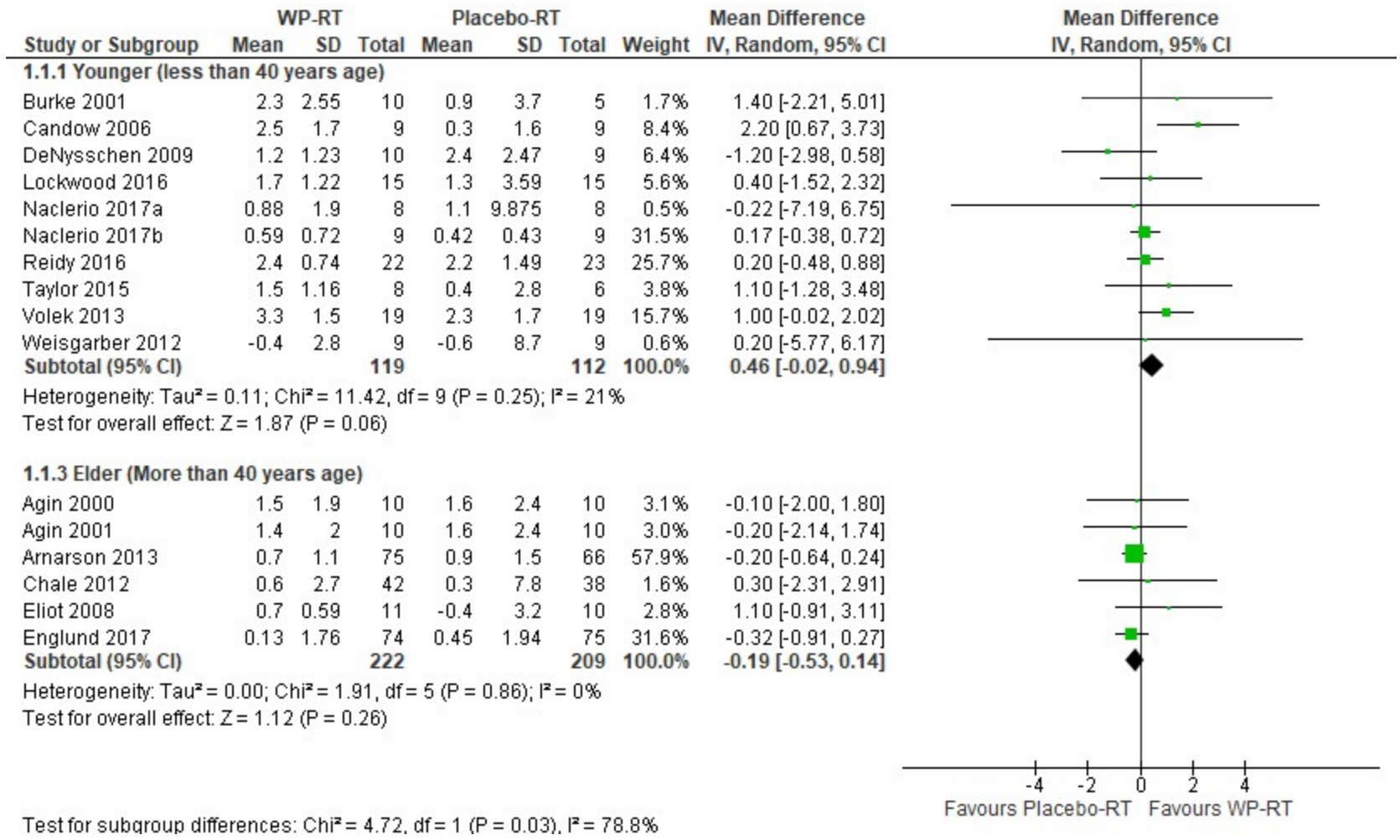


Figure S2: A forest graph showing the subgroup (younger vs elder) outcomes of a meta-analysis of mean differences in the change in lean body mass between WP-RT and placebo-RT groups

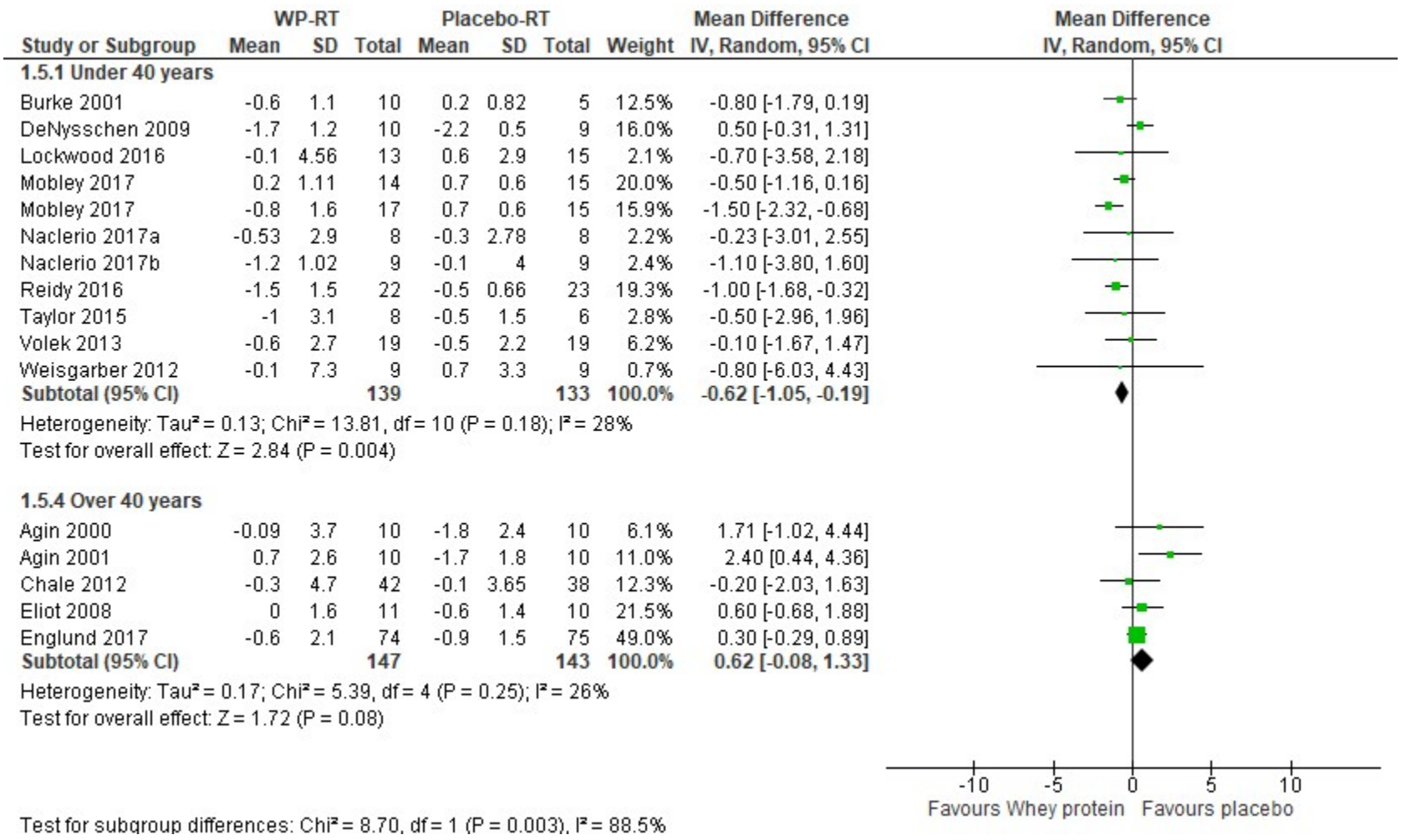


Figure S3: A forest graph showing the subgroup (younger vs older) outcomes of a meta-analysis of mean differences in the change in body fat mass between WP-RT and placebo-RT groups

Study or Subgroup	WP-RT Mean	WP-RT SD	WP-RT Total	Placebo-RT Mean	Placebo-RT SD	Placebo-RT Total	Weight	Std. Mean Difference IV, Random, 95% CI
1.9.1 Healthy participants								
Arazi 2011 Lower strength	5.7	6.16	20	3.7	8.25	20	2.3%	0.27 [-0.35, 0.89]
Arazi 2011 Upper strength	7.12	6.73	20	3.65	6.54	20	2.3%	0.51 [-0.12, 1.14]
Arnarson 2013 6-MWD	35.1	38	75	39.9	75.9	66	3.5%	-0.08 [-0.41, 0.25]
Arnarson 2013 Quad. str.	56.6	59.4	75	53.8	51.8	66	3.5%	0.05 [-0.28, 0.38]
Arnarson 2013 TUG	-0.6	1.7	75	-0.5	0.8	66	3.5%	-0.07 [-0.40, 0.26]
Bemnen 2009 BC	23	4	11	30	6	10	1.4%	-1.33 [-2.30, -0.37]
Bemnen 2009 BP	35	5	11	33	4	10	1.6%	0.42 [-0.45, 1.29]
Bemnen 2009 Lat pull	40	10	11	36	4	10	1.6%	0.49 [-0.38, 1.37]
Bemnen 2009 Military press	37	6	11	33	5	10	1.5%	0.69 [-0.20, 1.58]
Bemnen 2009 Triceps ext.	52	8	11	42	4	10	1.3%	1.49 [0.50, 2.49]
Burke 2001 BP	6.3	7	10	7.2	5.8	5	1.2%	-0.13 [-1.20, 0.95]
Burke 2001 KE	16.5	14.5	10	11.6	14.5	5	1.1%	0.32 [-0.76, 1.40]
Burke 2001 KF	1	77	10	2	12.5	5	1.2%	-0.01 [-1.09, 1.06]
Burke 2001 Squat	25.7	10.5	10	21.5	9.5	5	1.1%	0.39 [-0.70, 1.47]
Candow 2006 BP	8.2	10.5	9	4	11.5	9	1.4%	0.36 [-0.57, 1.30]
Candow 2006 Squat	26.7	11.5	9	14.1	13.5	9	1.3%	0.96 [-0.03, 1.95]
DeNysschen 2009 Bent-over-row	26.5	7.1	10	20.1	6.4	9	1.4%	0.90 [-0.05, 1.86]
DeNysschen 2009 BP	17.4	8.7	10	17.5	6.7	9	1.5%	-0.01 [-0.91, 0.89]
DeNysschen 2009 DB BP	10.9	3.4	10	12.2	1.9	9	1.5%	-0.44 [-1.36, 0.47]
DeNysschen 2009 Fly	11.3	2.35	10	11.4	2.15	9	1.5%	-0.04 [-0.94, 0.86]
DeNysschen 2009 I Arm Row	15.8	3.1	10	11.3	3.1	9	1.2%	1.39 [0.36, 2.41]
DeNysschen 2009 Lateral rises	5.6	1.35	10	4	1.6	9	1.3%	1.04 [0.06, 2.01]
DeNysschen 2009 Lunges	34.2	8.95	10	37.5	4.4	9	1.5%	-0.44 [-1.35, 0.47]
DeNysschen 2009 Shrugs	35	9.35	10	32	10.2	9	1.5%	0.29 [-0.61, 1.20]
DeNysschen 2009 SP	10.7	3.5	10	8.6	1.75	9	1.4%	0.71 [-0.22, 1.65]
DeNysschen 2009 Squats	39.4	9.35	10	33.7	11.3	9	1.4%	0.53 [-0.39, 1.45]
DeNysschen 2009 Triceps extens.	10.9	3.15	10	9.4	2.4	9	1.4%	0.51 [-0.41, 1.43]
DeNysschen 2009 Upright row	17.1	5.65	10	12.3	3.5	9	1.4%	0.96 [-0.00, 1.93]
Erskine 2012 1-RM	30	45.5	17	39	46	16	2.1%	-0.19 [-0.88, 0.49]
Erskine 2012 Elbow flexion	4.9	3.2	17	5	3.45	16	2.1%	-0.03 [-0.71, 0.65]
Lockwood 2016 H-WPC BP	6	7.21	13	6	9.24	15	1.9%	0.00 [-0.74, 0.74]
Lockwood 2016 H-WPC Sq	50	18	13	43	20.4	15	1.9%	0.35 [-0.40, 1.10]
Lockwood 2016 HL-WPC BP	6	7.75	13	6	8.87	15	1.9%	0.00 [-0.74, 0.74]
Lockwood 2016 HL-WPC Sq	45	19.4	13	43	19.7	15	1.9%	0.10 [-0.64, 0.84]
Lockwood 2016 WPC BP	4	7.21	13	6	9.24	15	1.9%	-0.23 [-0.98, 0.51]
Lockwood 2016 WPC sq	40	18	13	43	20.4	15	1.9%	-0.15 [-0.89, 0.59]
Mobley 2017 H-WPC BP	14	33	14	13	28.2	15	1.9%	0.03 [-0.70, 0.76]
Mobley 2017 H-WPC Sq	35	45.4	14	41	21.1	15	1.9%	-0.17 [-0.90, 0.56]
Mobley 2017 WPC BP	14	33.7	14	13	29.5	15	1.9%	0.03 [-0.70, 0.76]
Mobley 2017 WPC Squat	37	52.4	14	41	23.3	15	1.9%	-0.10 [-0.83, 0.63]
Naclerio 2017a BP	4.37	14.5	8	6.9	27.7	8	1.3%	-0.11 [-1.09, 0.87]
Naclerio 2017a Squat	15.9	17.3	8	17.6	29.5	8	1.3%	-0.07 [-1.05, 0.91]
Reidy 2016 CP	34	17.1	22	38	15.6	23	2.4%	-0.24 [-0.83, 0.35]
Reidy 2016 KE	64	31.8	22	64	28.7	23	2.4%	0.00 [-0.58, 0.58]
Reidy 2016 Squat	100	48.9	22	94	49.1	23	2.4%	0.12 [-0.46, 0.71]
Sugihara 2017 CP	2.8	8.8	15	1.2	7.45	16	2.0%	0.19 [-0.51, 0.90]
Sugihara 2017 KE	4.5	1.11	15	2.3	4.35	16	1.9%	0.66 [-0.06, 1.39]
Sugihara 2017 total	10.3	21.9	15	5.8	22.3	16	2.0%	0.20 [-0.51, 0.90]
Sugihara J 2017 Preacher curl	3	4.3	15	2.3	4.35	16	2.0%	0.16 [-0.55, 0.86]
Taylor 2015 BP	4.9	2.1	8	2.3	1.4	6	1.0%	1.32 [0.12, 2.53]
Taylor 2015 LP	31.4	17.5	8	26.5	20.2	6	1.2%	0.25 [-0.82, 1.31]
Weisgarber 2012 BC	107	45	9	30	23	9	1.0%	2.05 [0.86, 3.25]
Weisgarber 2012 LE	304	116	9	38	98	9	0.9%	2.36 [1.09, 3.63]
Weisgarber 2012 LP	716	170	9	329	298	9	1.1%	1.52 [0.44, 2.60]
Weisgarber 2012 SP	185	78	9	39	41	9	0.9%	2.23 [0.99, 3.47]
Weisgarber 2015 BC	5.8	4.45	10	3.5	4.25	10	1.5%	0.51 [-0.39, 1.40]
Weisgarber 2015 LC	-1.7	9.65	10	1	9.65	10	1.5%	-0.27 [-1.15, 0.61]
Weisgarber 2015 LE	5.5	12.6	10	5.2	14.8	10	1.5%	0.02 [-0.86, 0.90]
Weisgarber 2015 Triceps ext.	9.5	2.95	10	9.2	3.45	10	1.5%	0.09 [-0.79, 0.97]
Subtotal (95% CI)			**900**			**853**	**100.0%**	**0.25 [0.11, 0.38]**
Heterogeneity: Tau² = 0.10; Chi² = 99.89, df = 58 (P = 0.0005); I² = 42%								
Test for overall effect: Z = 3.63 (P = 0.0003)								
1.9.2 Health-compromised participants								
Agin 2001 BC	11.3	6.35	10	13.4	6.25	10	4.5%	-0.32 [-1.20, 0.56]
Agin 2001 BP	23.7	15	10	24.2	16.9	10	4.6%	-0.03 [-0.91, 0.85]
Agin 2001 LC	12.4	14.3	10	19.8	7.3	10	4.4%	-0.62 [-1.53, 0.28]
Agin 2001 Leg ext.	31.5	16	10	46.1	12.5	10	4.1%	-0.97 [-1.91, -0.03]
Agin 2001 Seated back row	25.3	13.8	10	36.2	12.8	10	4.3%	-0.78 [-1.70, 0.13]
Agin 2001 SP	18.2	8.1	10	21	10.2	10	4.5%	-0.29 [-1.17, 0.59]
Agin 2001 Triceps ext.	13.2	5.35	10	20.4	6.1	10	3.9%	-1.20 [-2.17, -0.23]
Chale 2012 KE Left	127	172	42	83	143	38	12.2%	0.27 [-0.17, 0.72]
Chale 2012 KE Right	92	117	42	79	159	38	12.2%	0.09 [-0.35, 0.53]
Chale 2012 LP	260	449	42	209	495	38	12.2%	0.11 [-0.33, 0.55]
Englund 2017 KE	-0.2	22.3	74	0.72	22.8	75	16.5%	-0.04 [-0.36, 0.28]
Englund 2017 KF	7.27	18	74	9.08	17.9	75	16.5%	-0.10 [-0.42, 0.22]
Subtotal (95% CI)			**344**			**334**	**100.0%**	**-0.14 [-0.35, 0.06]**
Heterogeneity: Tau² = 0.04; Chi² = 16.63, df = 11 (P = 0.12); I² = 34%								
Test for overall effect: Z = 1.35 (P = 0.18)								
Test for subgroup differences: Chi² = 9.67, df = 1 (P = 0.002), I² = 89.7%								

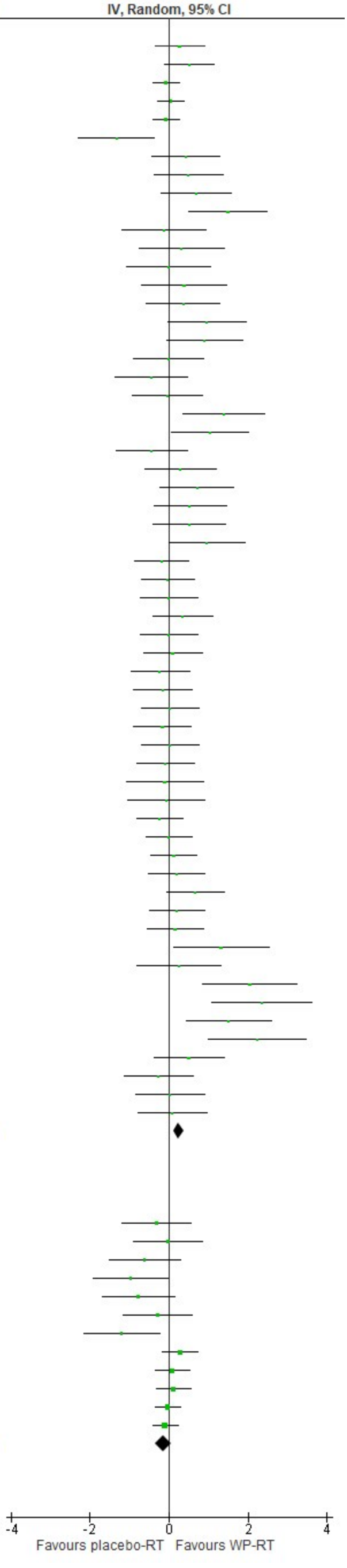


Figure S4: A forest graph showing the subgroup (with vs without a pathological condition) standardized mean differences in the change in muscular strength between WP-RT and placebo-RT groups. Abbreviations: BC, bicep curl; BP, bench press; CP, chest press; KE, knee extension; KF, knee flexion; LE, leg extension; LC, leg curl; SP, shoulder press

Study or Subgroup	WP-RT Mean	WP-RT SD	WP-RT Total	Placebo-RT Mean	Placebo-RT SD	Placebo-RT Total	Weight	Std. Mean Difference IV, Random, 95% CI
1.7.1 Young participants under 40 years of age								
Arazi 2011 Lower strength	5.7	6.16	20	3.7	8.25	20	3.3%	0.27 [-0.35, 0.89]
Arazi 2011 Upper strength	7.12	6.73	20	3.65	6.54	20	3.2%	0.51 [-0.12, 1.14]
Burke 2001 BP	6.3	7	10	7.2	5.8	5	1.7%	-0.13 [-1.20, 0.95]
Burke 2001 KE	16.5	14.5	10	11.6	14.5	5	1.7%	0.32 [-0.76, 1.40]
Burke 2001 KF	1	77	10	2	12.5	5	1.8%	-0.01 [-1.09, 1.06]
Burke 2001 Squat	25.7	10.5	10	21.5	9.5	5	1.7%	0.39 [-0.70, 1.47]
Candow 2006 BP	8.2	10.5	9	4	11.5	9	2.1%	0.36 [-0.57, 1.30]
Candow 2006 Squat	26.7	11.5	9	14.1	13.5	9	2.0%	0.96 [-0.03, 1.95]
DeNysschen 2009 Bent-over-row	26.5	7.1	10	20.1	6.4	9	2.0%	0.90 [-0.05, 1.86]
DeNysschen 2009 BP	17.4	8.7	10	17.5	6.7	9	2.2%	-0.01 [-0.91, 0.89]
DeNysschen 2009 DB BP	10.9	3.4	10	12.2	1.9	9	2.2%	-0.44 [-1.36, 0.47]
DeNysschen 2009 Fly	11.3	2.35	10	11.4	2.15	9	2.2%	-0.04 [-0.94, 0.86]
DeNysschen 2009 I Arm Row	15.8	3.1	10	11.3	3.1	9	1.9%	1.39 [0.36, 2.41]
DeNysschen 2009 Lateral rises	5.6	1.35	10	4	1.6	9	2.0%	1.04 [0.06, 2.01]
DeNysschen 2009 Lunges	34.2	8.95	10	37.5	4.4	9	2.2%	-0.44 [-1.35, 0.47]
DeNysschen 2009 Shrugs	35	9.35	10	32	10.2	9	2.2%	0.29 [-0.61, 1.20]
DeNysschen 2009 SP	10.7	3.5	10	8.6	1.75	9	2.1%	0.71 [-0.22, 1.65]
DeNysschen 2009 Squats	39.4	9.35	10	33.7	11.3	9	2.1%	0.53 [-0.39, 1.45]
DeNysschen 2009 Triceps extens.	10.9	3.15	10	9.4	2.4	9	2.2%	0.51 [-0.41, 1.43]
DeNysschen 2009 Upright row	17.1	5.65	10	12.3	3.5	9	2.0%	0.96 [-0.00, 1.93]
Erskine 2012 1-RM	30	45.5	17	39	46	16	3.0%	-0.19 [-0.88, 0.49]
Erskine 2012 Elbow flexion	4.9	3.2	17	5	3.45	16	3.0%	-0.03 [-0.71, 0.65]
Lockwood 2016 H-WPC BP	6	7.21	13	6	9.24	15	2.8%	0.00 [-0.74, 0.74]
Lockwood 2016 H-WPC Sq	50	18	13	43	20.4	15	2.7%	0.35 [-0.40, 1.10]
Lockwood 2016 HL-WPC BP	6	7.75	13	6	8.87	15	2.8%	0.00 [-0.74, 0.74]
Lockwood 2016 HL-WPC Sq	45	19.4	13	43	19.7	15	2.8%	0.10 [-0.64, 0.84]
Lockwood 2016 WPC BP	4	7.21	13	6	9.24	15	2.7%	-0.23 [-0.98, 0.51]
Lockwood 2016 WPC sq	40	18	13	43	20.4	15	2.7%	-0.15 [-0.89, 0.59]
Mobley 2017 H-WPC BP	14	33	14	13	28.2	15	2.8%	0.03 [-0.70, 0.76]
Mobley 2017 H-WPC Sq	35	45.4	14	41	21.1	15	2.8%	-0.17 [-0.90, 0.56]
Mobley 2017 WPC BP	14	33.7	14	13	29.5	15	2.8%	0.03 [-0.70, 0.76]
Mobley 2017 WPC Squat	37	52.4	14	41	23.3	15	2.8%	-0.10 [-0.83, 0.63]
Naclerio 2017a BP	4.37	14.5	8	6.9	27.7	8	2.0%	-0.11 [-1.09, 0.87]
Naclerio 2017a Squat	15.9	17.3	8	17.6	29.5	8	2.0%	-0.07 [-1.05, 0.91]
Reidy 2016 CP	34	17.1	22	38	15.6	23	3.4%	-0.24 [-0.83, 0.35]
Reidy 2016 KE	64	31.8	22	64	28.7	23	3.4%	0.00 [-0.58, 0.58]
Reidy 2016 Squat	100	48.9	22	94	49.1	23	3.4%	0.12 [-0.46, 0.71]
Taylor 2015 BP	4.9	2.1	8	2.3	1.4	6	1.5%	1.32 [0.12, 2.53]
Taylor 2015 LP	31.4	17.5	8	26.5	20.2	6	1.8%	0.25 [-0.82, 1.31]
Weisgarber 2012 BC	107	45	9	30	23	9	1.5%	2.05 [0.86, 3.25]
Weisgarber 2012 LE	304	116	9	38	98	9	1.4%	2.36 [1.09, 3.63]
Weisgarber 2012 LP	716	170	9	329	298	9	1.7%	1.52 [0.44, 2.60]
Weisgarber 2012 SP	185	78	9	39	41	9	1.4%	2.23 [0.99, 3.47]
Subtotal (95% CI)			**520**			**501**	**100.0%**	**0.30 [0.13, 0.47]**
Heterogeneity: Tau² = 0.13; Chi² = 72.13, df = 42 (P = 0.003); I² = 42%								
Test for overall effect: Z = 3.42 (P = 0.0006)								
1.7.3 Older participants over 40 years of age								
Arnarson 2013 6-MWD	35.1	38	75	39.9	75.9	66	12.5%	-0.08 [-0.41, 0.25]
Arnarson 2013 Quad. str.	56.6	59.4	75	53.8	51.8	66	12.5%	0.05 [-0.28, 0.38]
Arnarson 2013 TUG	-0.6	1.7	75	-0.5	0.8	66	12.5%	-0.07 [-0.40, 0.26]
Bemnen 2009 BC	23	4	11	30	6	10	3.8%	-1.33 [-2.30, -0.37]
Bemnen 2009 BP	35	5	11	33	4	10	4.5%	0.42 [-0.45, 1.29]
Bemnen 2009 Lat pull	40	10	11	36	4	10	4.5%	0.49 [-0.38, 1.37]
Bemnen 2009 Military press	37	6	11	33	5	10	4.4%	0.69 [-0.20, 1.58]
Bemnen 2009 Triceps ext.	52	8	11	42	4	10	3.7%	1.49 [0.50, 2.49]
Sugihara 2017 CP	2.8	8.8	15	1.2	7.45	16	6.0%	0.19 [-0.51, 0.90]
Sugihara 2017 KE	4.5	1.11	15	2.3	4.35	16	5.8%	0.66 [-0.06, 1.39]
Sugihara 2017 total	10.3	21.9	15	5.8	22.3	16	6.0%	0.20 [-0.51, 0.90]
Sugihara J 2017 Preacher curl	3	4.3	15	2.3	4.35	16	6.1%	0.16 [-0.55, 0.86]
Weisgarber 2015 BC	5.8	4.45	10	3.5	4.25	10	4.3%	0.51 [-0.39, 1.40]
Weisgarber 2015 LC	-1.7	9.65	10	1	9.65	10	4.4%	-0.27 [-1.15, 0.61]
Weisgarber 2015 LE	5.5	12.6	10	5.2	14.8	10	4.5%	0.02 [-0.86, 0.90]
Weisgarber 2015 Triceps ext.	9.5	2.95	10	9.2	3.45	10	4.4%	0.09 [-0.79, 0.97]
Subtotal (95% CI)			**380**			**352**	**100.0%**	**0.15 [-0.06, 0.36]**
Heterogeneity: Tau² = 0.07; Chi² = 25.29, df = 15 (P = 0.05); I² = 41%								
Test for overall effect: Z = 1.37 (P = 0.17)								
Test for subgroup differences: Chi² = 1.12, df = 1 (P = 0.29), I² = 10.5%								

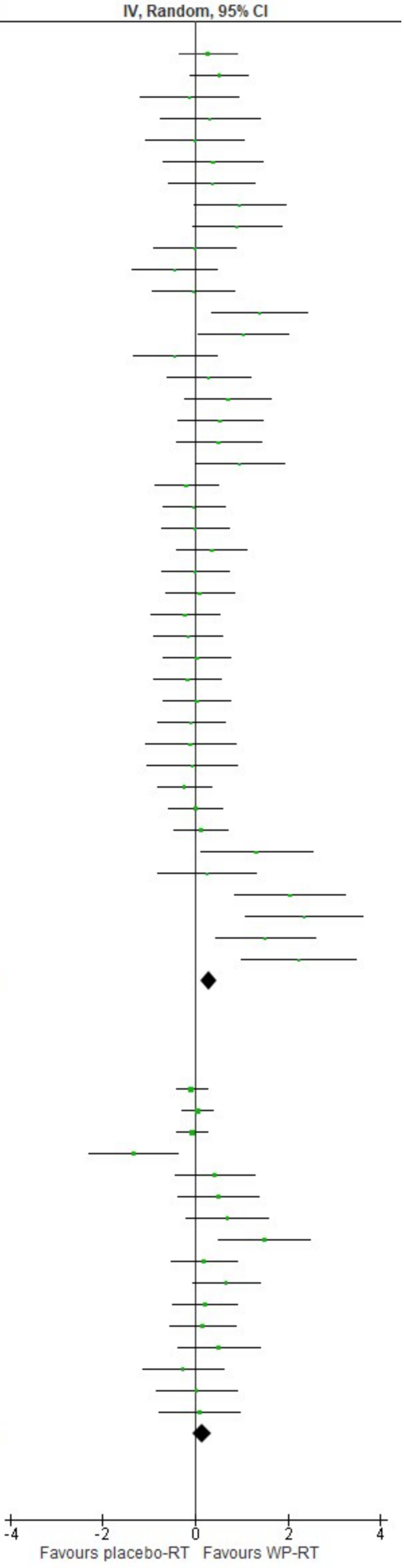


Figure S5: A forest graph showing subgroup (younger vs older participants) standardized mean differences in the change in muscular strength between WP-RT and placebo-RT groups. Abbreviations: BC, bicep curl; BP, bench press; CP, chest press; KE, knee extension; KF, knee flexion; LE, leg extension; LC, leg curl; SP, shoulder press

Study or Subgroup	WP-RT Mean	SD	Total	Placebo-RT Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
1.9.1 Others								
Arazi 2011 Lower strength	5.7	6.16	20	3.7	8.25	20	5.7%	0.27 [-0.35, 0.89]
Arazi 2011 Upper strength	7.12	6.73	20	3.65	6.54	20	5.6%	0.51 [-0.12, 1.14]
Arnarson 2013 6-MWD	35.1	38	75	39.9	75.9	66	9.9%	-0.08 [-0.41, 0.25]
Arnarson 2013 Quad. str.	56.6	59.4	75	53.8	51.8	66	9.9%	0.05 [-0.28, 0.38]
Arnarson 2013 TUG	-0.6	1.7	75	-0.5	0.8	66	9.9%	-0.07 [-0.40, 0.26]
Bemnen 2009 Lat pull	40	10	11	36	4	10	3.6%	0.49 [-0.38, 1.37]
Bemnen 2009 Military press	37	6	11	33	5	10	3.5%	0.69 [-0.20, 1.58]
Bemnen 2009 Triceps ext.	52	8	11	42	4	10	2.9%	1.49 [0.50, 2.49]
DeNysschen 2009 Bent-over-row	26.5	7.1	10	20.1	6.4	9	3.1%	0.90 [-0.05, 1.86]
DeNysschen 2009 Fly	11.3	2.35	10	11.4	2.15	9	3.4%	-0.04 [-0.94, 0.86]
DeNysschen 2009 I Arm Row	15.8	3.1	10	11.3	3.1	9	2.8%	1.39 [0.36, 2.41]
DeNysschen 2009 Lateral rises	5.6	1.35	10	4	1.6	9	3.0%	1.04 [0.06, 2.01]
DeNysschen 2009 Lunges	34.2	8.95	10	37.5	4.4	9	3.3%	-0.44 [-1.35, 0.47]
DeNysschen 2009 Triceps extens.	10.9	3.15	10	9.4	2.4	9	3.3%	0.51 [-0.41, 1.43]
DeNysschen 2009 Upright row	17.1	5.65	10	12.3	3.5	9	3.1%	0.96 [-0.00, 1.93]
Erskine 2012 1-RM	30	45.5	17	39	46	16	5.0%	-0.19 [-0.88, 0.49]
Erskine 2012 Elbow flexion	4.9	3.2	17	5	3.45	16	5.0%	-0.03 [-0.71, 0.65]
Sugihara 2017 total	10.3	21.9	15	5.8	22.3	16	4.8%	0.20 [-0.51, 0.90]
Sugihara J 2017 Preacher curl	3	4.3	15	2.3	4.35	16	4.8%	0.16 [-0.55, 0.86]
Weisgarber 2015 LC	-1.7	9.65	10	1	9.65	10	3.5%	-0.27 [-1.15, 0.61]
Weisgarber 2015 Triceps ext.	9.5	2.95	10	9.2	3.45	10	3.6%	0.09 [-0.79, 0.97]
Subtotal (95% CI)			**452**			**415**	**100.0%**	**0.25 [0.06, 0.44]**
Heterogeneity: Tau² = 0.07; Chi² = 32.80, df = 20 (P = 0.04); I² = 39%								
Test for overall effect: Z = 2.54 (P = 0.01)								
1.9.2 Bench press								
Bemnen 2009 BP	35	5	11	33	4	10	8.0%	0.42 [-0.45, 1.29]
Burke 2001 BP	6.3	7	10	7.2	5.8	5	5.2%	-0.13 [-1.20, 0.95]
Candow 2006 BP	8.2	10.5	9	4	11.5	9	6.9%	0.36 [-0.57, 1.30]
DeNysschen 2009 BP	17.4	8.7	10	17.5	6.7	9	7.4%	-0.01 [-0.91, 0.89]
DeNysschen 2009 DB BP	10.9	3.4	10	12.2	1.9	9	7.2%	-0.44 [-1.36, 0.47]
Lockwood 2016 H-WPC BP	6	7.21	13	6	9.24	15	10.9%	0.00 [-0.74, 0.74]
Lockwood 2016 HL-WPC BP	6	7.75	13	6	8.87	15	10.9%	0.00 [-0.74, 0.74]
Lockwood 2016 WPC BP	4	7.21	13	6	9.24	15	10.8%	-0.23 [-0.98, 0.51]
Mobley 2017 H-WPC BP	14	33	14	13	28.2	15	11.3%	0.03 [-0.70, 0.76]
Mobley 2017 WPC BP	14	33.7	14	13	29.5	15	11.3%	0.03 [-0.70, 0.76]
Naclerio 2017a BP	4.37	14.5	8	6.9	27.7	8	6.2%	-0.11 [-1.09, 0.87]
Taylor 2015 BP	4.9	2.1	8	2.3	1.4	6	4.1%	1.32 [0.12, 2.53]
Subtotal (95% CI)			**133**			**131**	**100.0%**	**0.05 [-0.20, 0.29]**
Heterogeneity: Tau² = 0.00; Chi² = 7.35, df = 11 (P = 0.77); I² = 0%								
Test for overall effect: Z = 0.39 (P = 0.70)								
1.9.4 Squat								
Burke 2001 Sq	25.7	10.5	10	21.5	9.5	5	5.2%	0.39 [-0.70, 1.47]
Candow 2006 Sq	26.7	11.5	9	14.1	13.5	9	6.3%	0.96 [-0.03, 1.95]
DeNysschen 2009 Sq	39.4	9.35	10	33.7	11.3	9	7.3%	0.53 [-0.39, 1.45]
Lockwood 2016 H-WPC Sq	50	18	13	43	20.4	15	11.0%	0.35 [-0.40, 1.10]
Lockwood 2016 HL-WPC Sq	45	19.4	13	43	19.7	15	11.2%	0.10 [-0.64, 0.84]
Lockwood 2016 WPC Sq	40	18	13	43	20.4	15	11.2%	-0.15 [-0.89, 0.59]
Mobley 2017 H-WPC Sq	35	45.4	14	41	21.1	15	11.6%	-0.17 [-0.90, 0.56]
Mobley 2017 WPC Sq	37	52.4	14	41	23.3	15	11.6%	-0.10 [-0.83, 0.63]
Naclerio 2017a Sq	15.9	17.3	8	17.6	29.5	8	6.4%	-0.07 [-1.05, 0.91]
Reidy 2016 Sq	100	48.9	22	94	49.1	23	18.1%	0.12 [-0.46, 0.71]
Subtotal (95% CI)			**126**			**129**	**100.0%**	**0.14 [-0.11, 0.39]**
Heterogeneity: Tau² = 0.00; Chi² = 5.67, df = 9 (P = 0.77); I² = 0%								
Test for overall effect: Z = 1.10 (P = 0.27)								
1.9.5 Chest / Shoulder / Leg press								
DeNysschen 2009 SP	10.7	3.5	10	8.6	1.75	9	16.6%	0.71 [-0.22, 1.65]
Reidy 2016 CP	34	17.1	22	38	15.6	23	20.4%	-0.24 [-0.83, 0.35]
Sugihara 2017 CP	2.8	8.8	15	1.2	7.45	16	19.2%	0.19 [-0.51, 0.90]
Taylor 2015 LP	31.4	17.5	8	26.5	20.2	6	15.2%	0.25 [-0.82, 1.31]
Weisgarber 2012 LP	716	170	9	329	298	9	15.1%	1.52 [0.44, 2.60]
Weisgarber 2012 SP	185	78	9	39	41	9	13.5%	2.23 [0.99, 3.47]
Subtotal (95% CI)			**73**			**72**	**100.0%**	**0.67 [-0.01, 1.36]**
Heterogeneity: Tau² = 0.51; Chi² = 17.93, df = 5 (P = 0.003); I² = 72%								
Test for overall effect: Z = 1.92 (P = 0.05)								
1.9.6 Knee Extension / Flexion								
Burke 2001 KE	16.5	14.5	10	11.6	14.5	5	14.3%	0.32 [-0.76, 1.40]
Burke 2001 KF	1	77	10	2	12.5	5	14.4%	-0.01 [-1.09, 1.06]
Reidy 2016 KE	64	31.8	22	64	28.7	23	22.2%	0.00 [-0.58, 0.58]
Sugihara 2017 KE	4.5	1.11	15	2.3	4.35	16	19.8%	0.66 [-0.06, 1.39]
Weisgarber 2012 LE	304	116	9	38	98	9	12.0%	2.36 [1.09, 3.63]
Weisgarber 2015 LE	5.5	12.6	10	5.2	14.8	10	17.3%	0.02 [-0.86, 0.90]
Subtotal (95% CI)			**76**			**68**	**100.0%**	**0.46 [-0.12, 1.04]**
Heterogeneity: Tau² = 0.30; Chi² = 12.70, df = 5 (P = 0.03); I² = 61%								
Test for overall effect: Z = 1.57 (P = 0.12)								
1.9.7 Bicep Curl								
Bemnen 2009 BC	23	4	11	30	6	10	33.7%	-1.33 [-2.30, -0.37]
Weisgarber 2012 BC	107	45	9	30	23	9	32.1%	2.05 [0.86, 3.25]
Weisgarber 2015 BC	5.8	4.45	10	3.5	4.25	10	34.2%	0.51 [-0.39, 1.40]
Subtotal (95% CI)			**30**			**29**	**100.0%**	**0.38 [-1.43, 2.20]**
Heterogeneity: Tau² = 2.30; Chi² = 19.33, df = 2 (P < 0.0001); I² = 90%								
Test for overall effect: Z = 0.41 (P = 0.68)								
Test for subgroup differences: Chi² = 4.58, df = 5 (P = 0.47), I² = 0%								

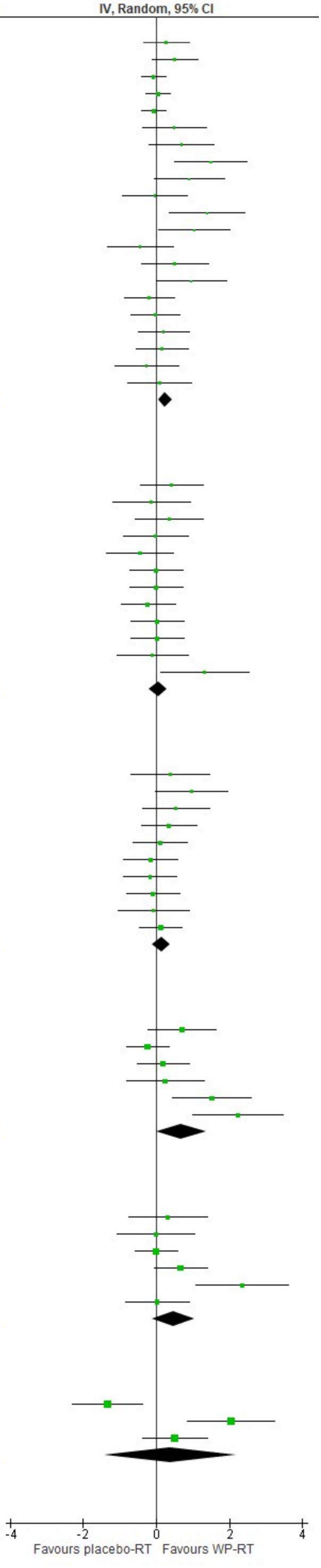
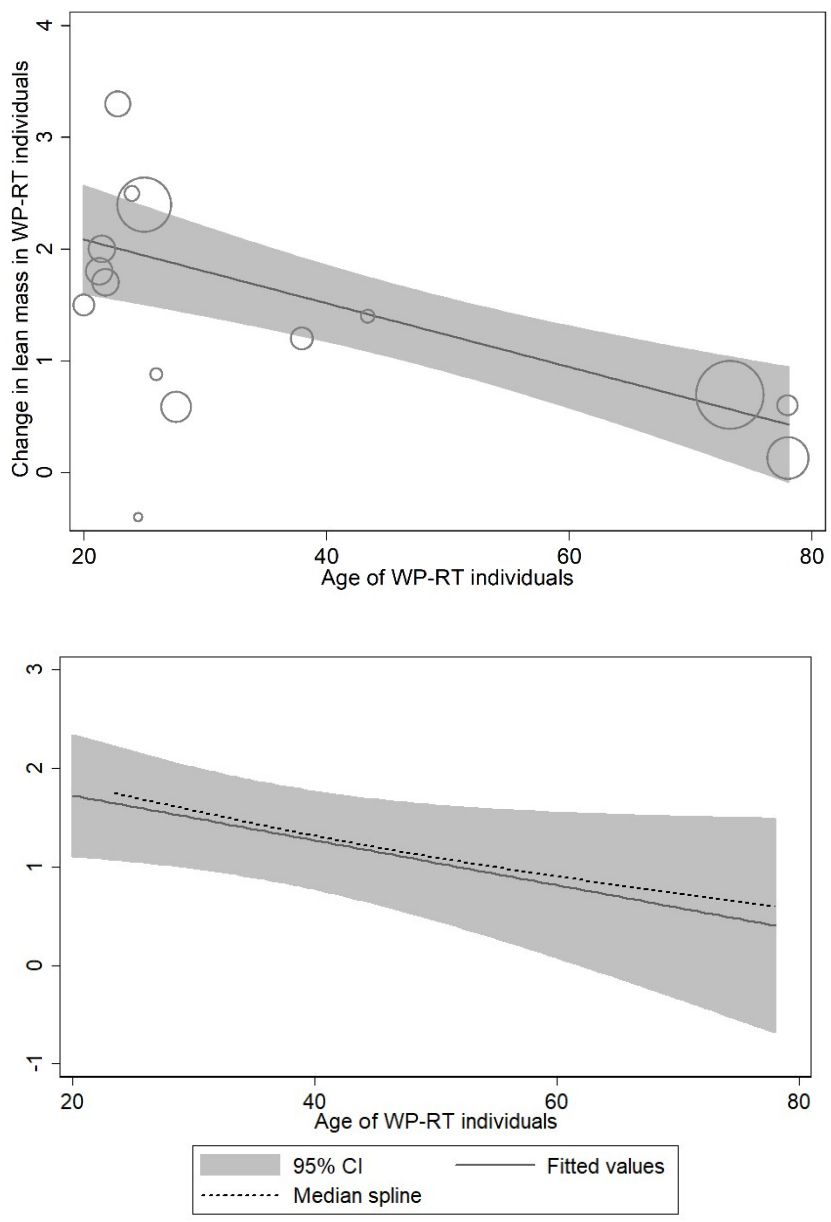


Figure S6: A forest graph showing subgroup (categorical) standardized mean differences in the change in muscular strength between WP-RT and placebo-RT groups. Abbreviations: BC, bicep curl; BP, bench press; CP, chest press; KE, knee extension; KF, knee flexion; LE, leg extension; LC, leg curl; SP, shoulder press.



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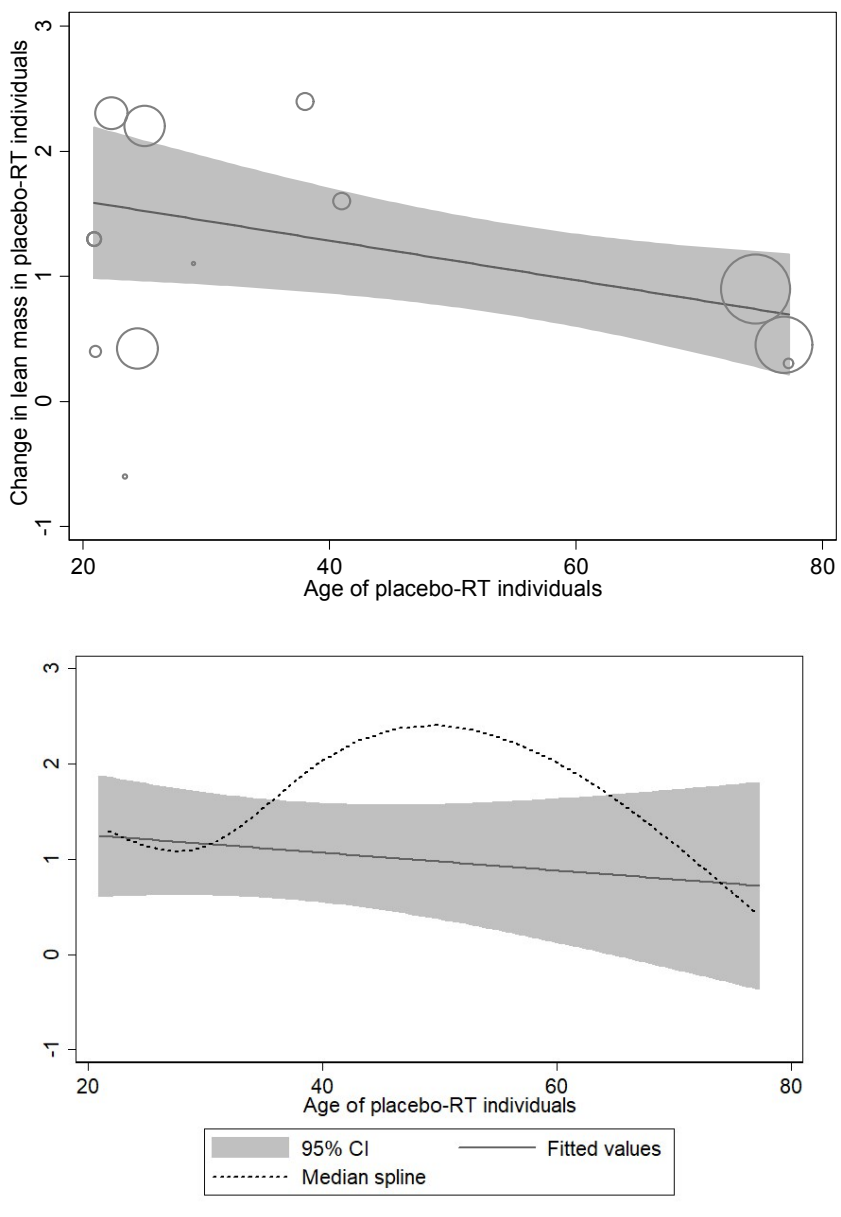

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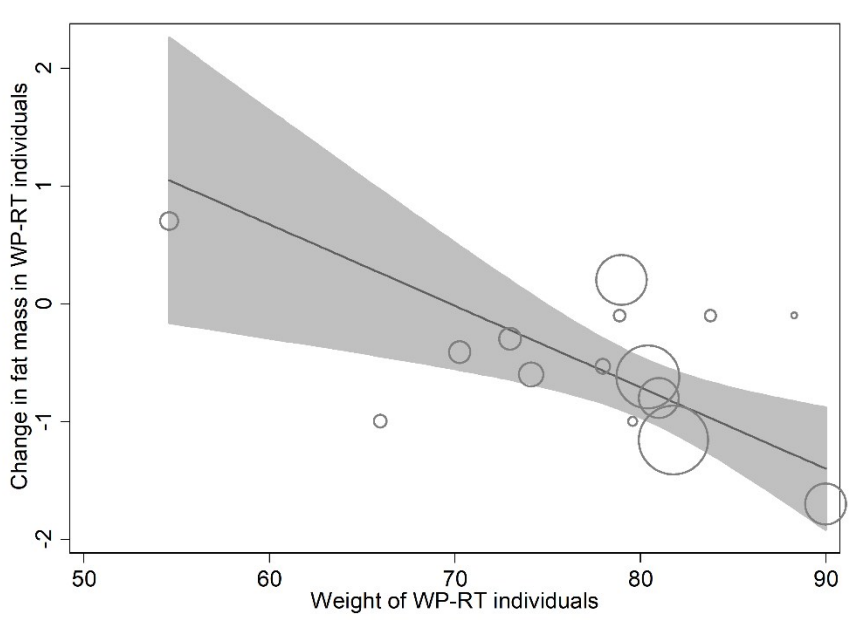

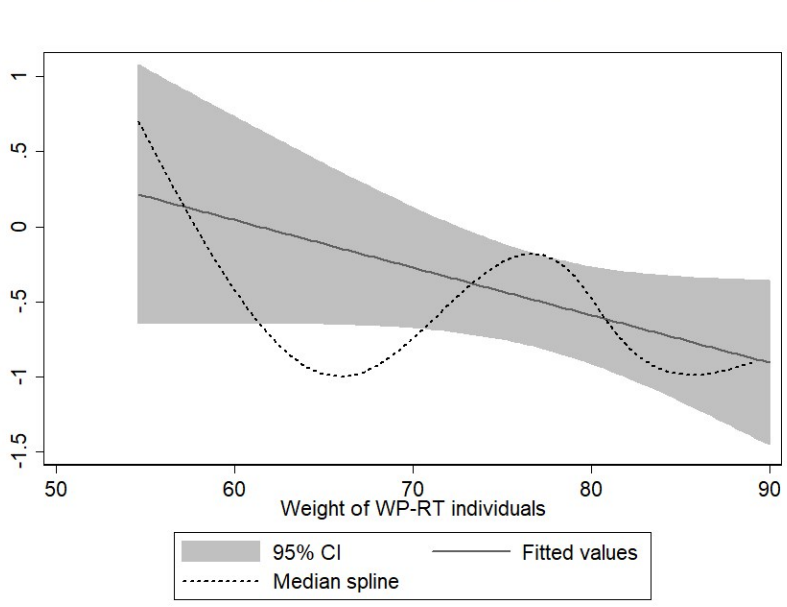

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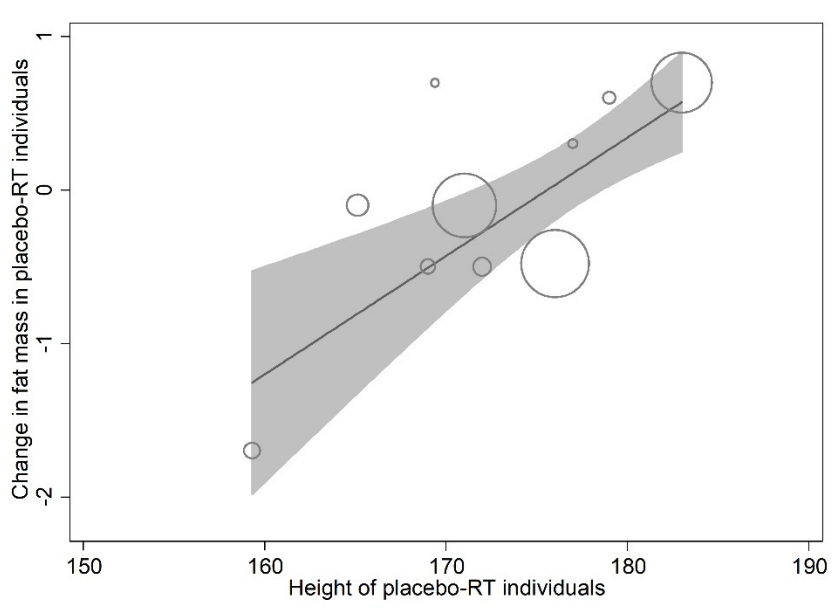
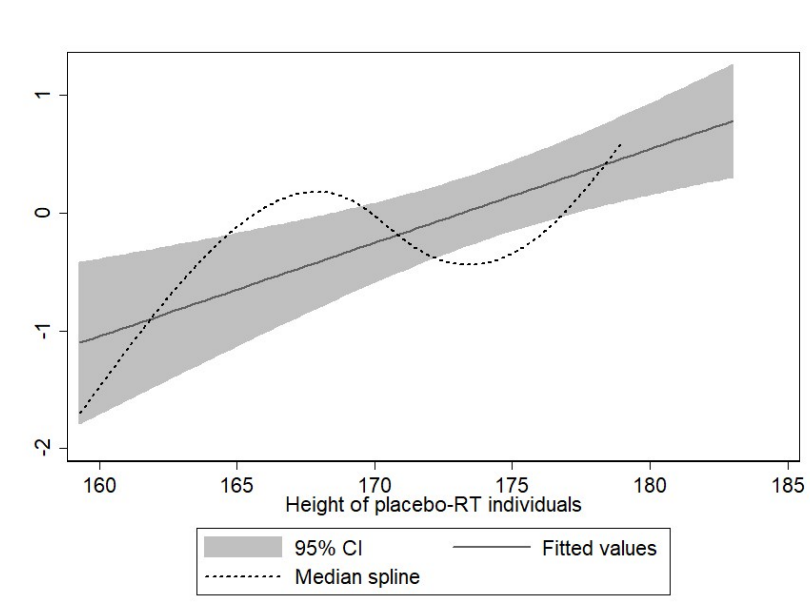
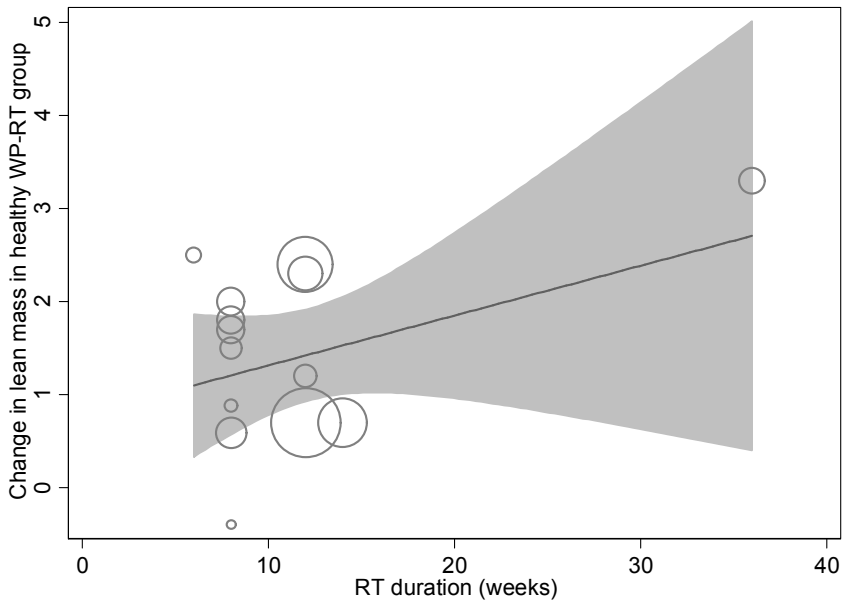
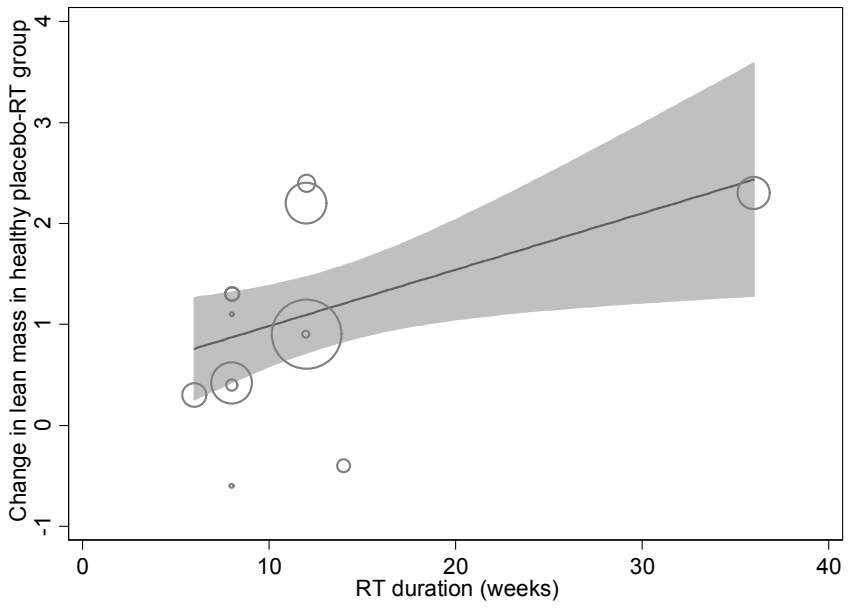


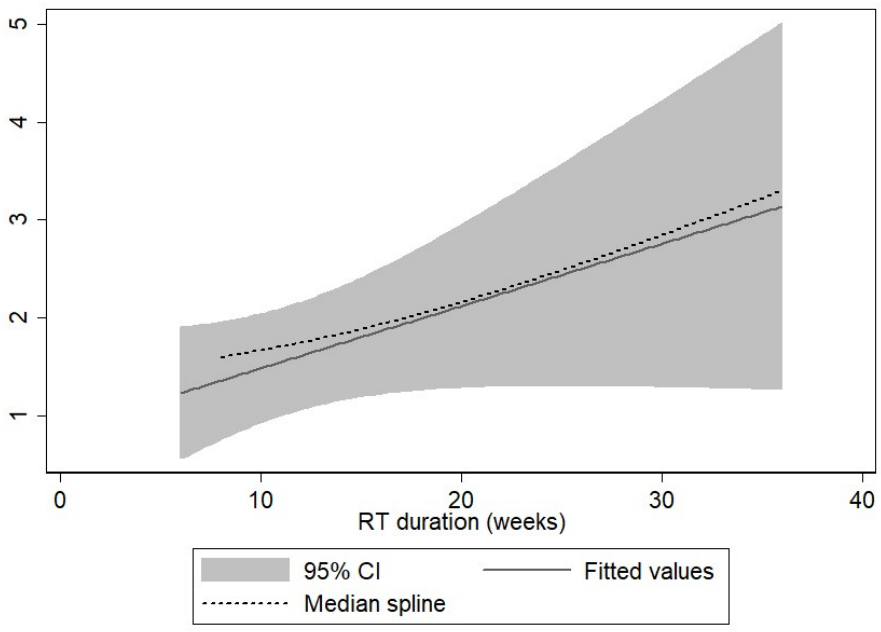


d

Figure S7: Metaregression outcomes of overall population. Scatterplots showing the relationships between (a) the change in lean mass and age of WP-RT individuals; (b) the change in lean mass and age of placebo-RT individuals; (c) the change in fat mass and body weight of WP-RT individuals; and (d) the change in fat mass and height of placebo-RT individuals. Below each figure is the median spline interpolated scatterplot indicating possibility of linearity/non-linearity of relationship.







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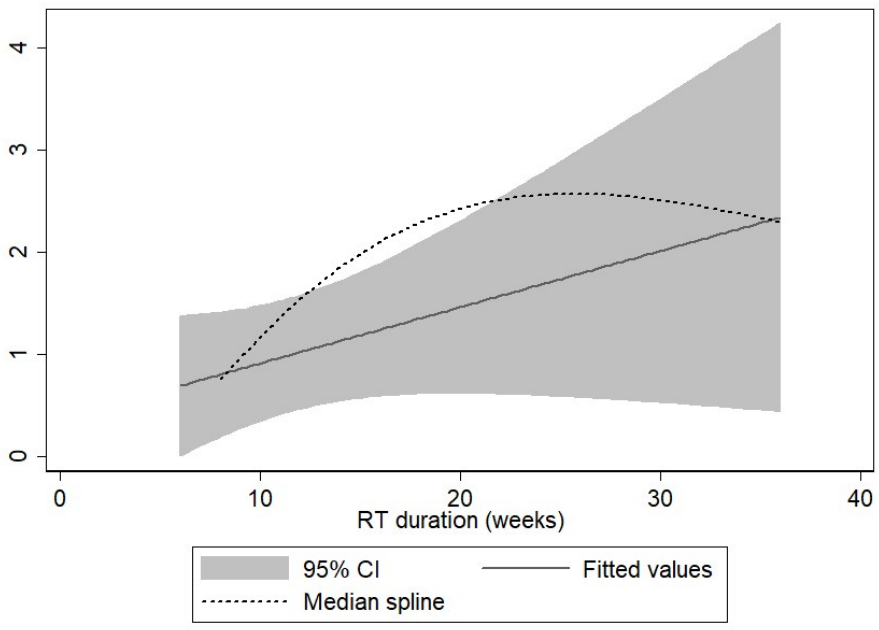

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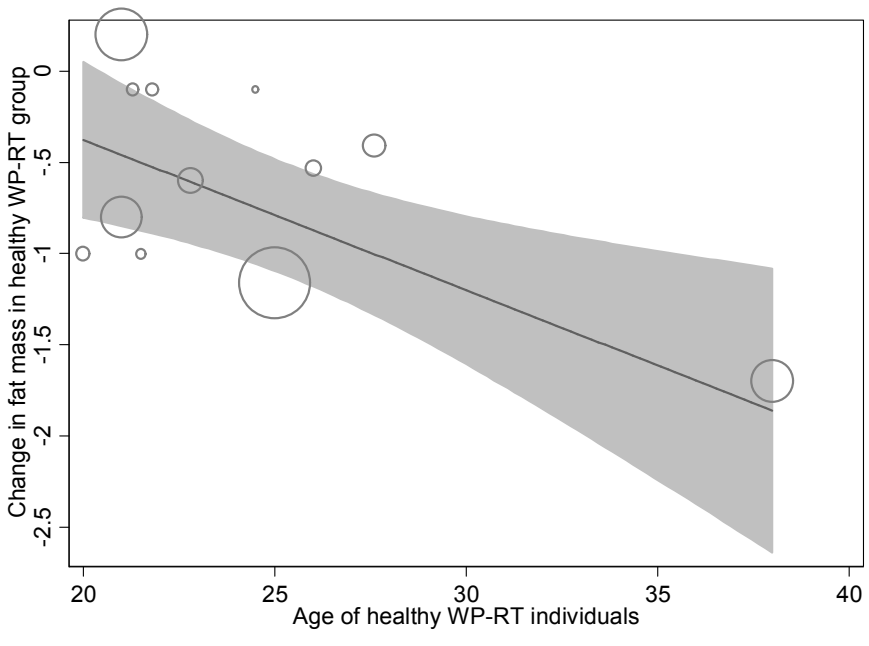

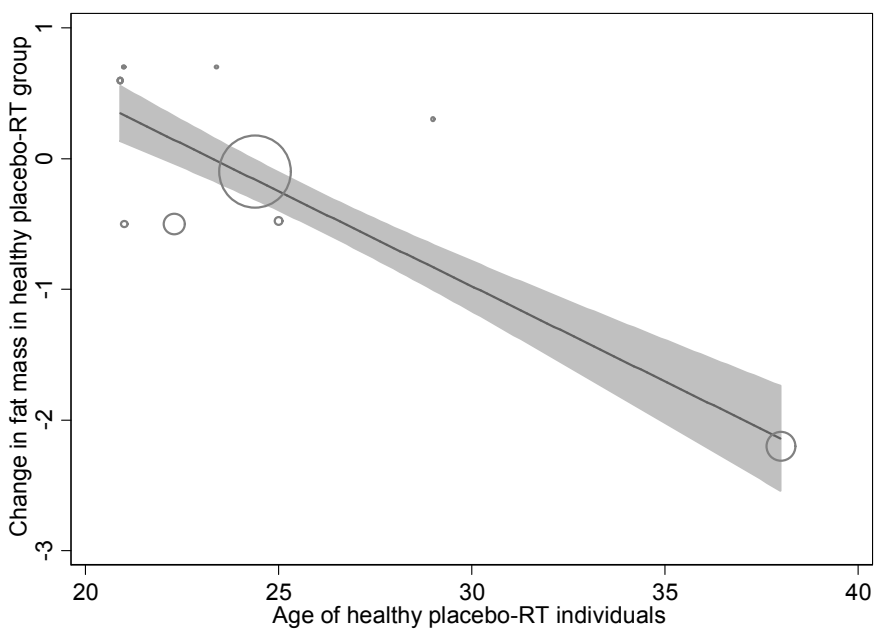

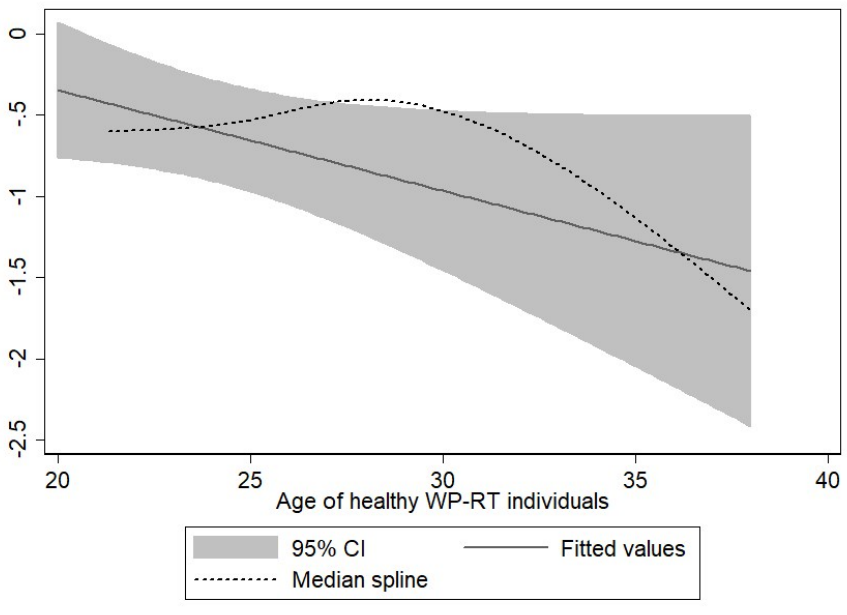

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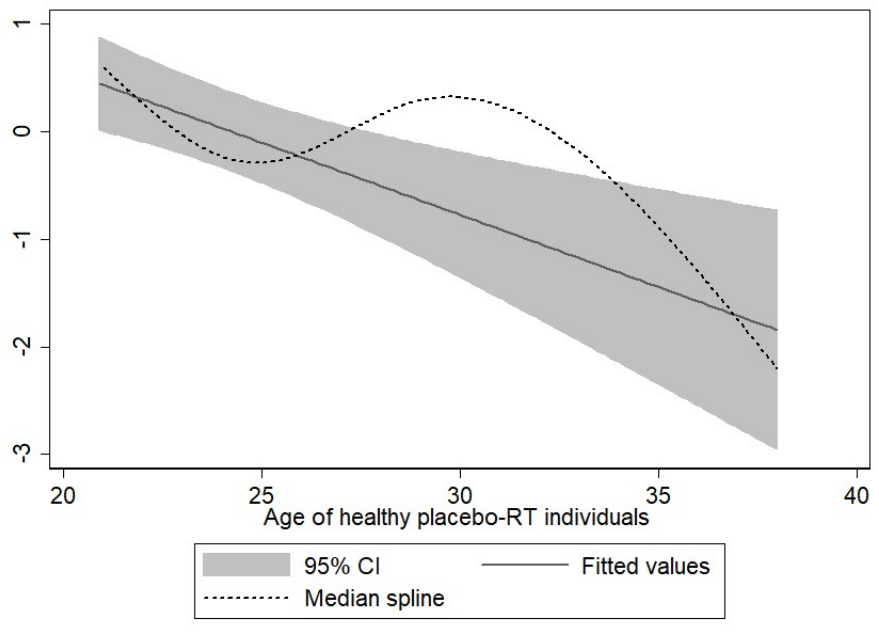

D

Figure S8: Metaregression outcomes of healthy individuals. Scatterplots showing the relationship between (a) the change in lean mass and RT duration in WP-RT group; (b) the change in lean mass and RT duration in placebo-RT group; (c) the relationship between the change in fat mass and the age of WP-RT group; and (d) the relationship between the change in fat mass and age of placebo-RT group. Below each figure is the median spline interpolated scatterplot indicating possibility of linearity/non-linearity of relationship.

Appendix 1 Literature search strategy

Search strategy	Search engine's strategy
whey protein - resistance training	("whey proteins"[MeSH Terms] OR ("whey"[All Fields] AND "proteins"[All Fields]) OR "whey proteins"[All Fields] OR ("whey"[All Fields] AND "protein"[All Fields]) OR "whey protein"[All Fields]) AND supplementation[All Fields] AND ("resistance training"[MeSH Terms] OR ("resistance"[All Fields] AND "training"[All Fields]) OR "resistance training"[All Fields]) AND ("random allocation"[MeSH Terms] OR ("random"[All Fields] AND "allocation"[All Fields]) OR "random allocation"[All Fields] OR "randomized"[All Fields]) AND ("clinical trials as topic"[MeSH Terms] OR ("clinical"[All Fields] AND "trials"[All Fields] AND "topic"[All Fields]) OR "clinical trials as topic"[All Fields] OR "trial"[All Fields]) AND ("sports"[MeSH Terms] OR "sports"[All Fields])
whey protein - supplementation - resistance training - body mass	("whey proteins"[MeSH Terms] OR ("whey"[All Fields] AND "proteins"[All Fields]) OR "whey proteins"[All Fields] OR ("whey"[All Fields] AND "protein"[All Fields]) OR "whey protein"[All Fields]) AND supplementation[All Fields] AND ("resistance training"[MeSH Terms] OR ("resistance"[All Fields] AND "training"[All Fields]) OR "resistance training"[All Fields]) AND ("body mass index"[MeSH Terms] OR ("body"[All Fields] AND "mass"[All Fields] AND "index"[All Fields]) OR "body mass index"[All Fields])
whey protein - supplementation - resistance training - lean mass	("whey proteins"[MeSH Terms] OR ("whey"[All Fields] AND "proteins"[All Fields]) OR "whey proteins"[All Fields] OR ("whey"[All Fields] AND "protein"[All Fields]) OR "whey protein"[All Fields]) AND supplementation[All Fields] AND ("resistance training"[MeSH Terms] OR ("resistance"[All Fields] AND "training"[All Fields]) OR "resistance training"[All Fields]) AND lean[All Fields] AND ("molecular weight"[MeSH Terms] OR ("molecular"[All Fields] AND "weight"[All Fields]) OR "molecular weight"[All Fields] OR "mass"[All Fields])
whey protein - supplementation - resistance training - fat mass	("whey proteins"[MeSH Terms] OR ("whey"[All Fields] AND "proteins"[All Fields]) OR "whey proteins"[All Fields] OR ("whey"[All Fields] AND "protein"[All Fields]) OR "whey protein"[All Fields]) AND supplementation[All Fields] AND ("resistance training"[MeSH Terms] OR ("resistance"[All Fields] AND "training"[All Fields]) OR "resistance training"[All Fields]) AND fat[All Fields] AND ("molecular weight"[MeSH Terms] OR ("molecular"[All Fields] AND "weight"[All Fields]) OR "molecular weight"[All Fields] OR "mass"[All Fields])
whey protein - supplementation - resistance training - muscle strength	("whey proteins"[MeSH Terms] OR ("whey"[All Fields] AND "proteins"[All Fields]) OR "whey proteins"[All Fields] OR ("whey"[All Fields] AND "protein"[All Fields]) OR "whey protein"[All Fields]) AND supplementation[All Fields] AND ("resistance training"[MeSH Terms] OR ("resistance"[All Fields] AND "training"[All Fields]) OR "resistance training"[All Fields]) AND ("muscle strength"[MeSH Terms] OR ("muscle"[All Fields] AND "strength"[All Fields]) OR "muscle strength"[All Fields])
whey protein - supplementation - resistance training - muscle - bench - chest - shoulder - leg - press	("whey proteins"[MeSH Terms] OR ("whey"[All Fields] AND "proteins"[All Fields]) OR "whey proteins"[All Fields] OR ("whey"[All Fields] AND "protein"[All Fields]) OR "whey protein"[All Fields]) AND supplementation[All Fields] AND ("resistance training"[MeSH Terms] OR ("resistance"[All Fields] AND "training"[All Fields]) OR "resistance training"[All Fields]) AND ("muscle strength"[MeSH Terms] OR ("muscle"[All Fields] AND "strength"[All Fields]) OR "muscle strength"[All Fields]) AND bench[All Fields] AND ("thorax"[MeSH Terms] OR "thorax"[All Fields] OR "chest"[All Fields]) AND ("shoulder"[MeSH Terms] OR "shoulder"[All Fields]) AND ("leg"[MeSH Terms] OR "leg"[All Fields]) AND press[All Fields]
whey protein - supplementation - resistance training - muscle - time up-and-go test - walking distance	("whey proteins"[MeSH Terms] OR ("whey"[All Fields] AND "proteins"[All Fields]) OR "whey proteins"[All Fields] OR ("whey"[All Fields] AND "protein"[All Fields]) OR "whey protein"[All Fields]) AND supplementation[All Fields] AND ("resistance training"[MeSH Terms] OR ("resistance"[All Fields] AND "training"[All Fields]) OR "resistance training"[All Fields]) AND ("muscles"[MeSH Terms] OR "muscles"[All Fields] OR "muscle"[All Fields]) AND ("time"[MeSH Terms] OR "time"[All Fields]) AND up-and-go[All Fields] AND ("research design"[MeSH Terms] OR ("research"[All Fields] AND "design"[All Fields]) OR "research design"[All Fields] OR "test"[All Fields]) AND ("walking"[MeSH Terms] OR "walking"[All Fields]) AND distance[All Fields]
whey protein - supplementation - resistance training - muscle extension - flexion	("whey proteins"[MeSH Terms] OR ("whey"[All Fields] AND "proteins"[All Fields]) OR "whey proteins"[All Fields] OR ("whey"[All Fields] AND "protein"[All Fields]) OR "whey protein"[All Fields]) AND supplementation[All Fields] AND ("resistance training"[MeSH Terms] OR ("resistance"[All Fields] AND "training"[All Fields]) OR "resistance training"[All Fields]) AND ("muscles"[MeSH Terms] OR "muscles"[All Fields] OR "muscle"[All Fields]) AND extension[All Fields] AND flexion[All Fields]
whey protein - supplementation - resistance training - muscle biceps - triceps - leg - curl	("whey proteins"[MeSH Terms] OR ("whey"[All Fields] AND "proteins"[All Fields]) OR "whey proteins"[All Fields] OR ("whey"[All Fields] AND "protein"[All Fields]) OR "whey protein"[All Fields]) AND supplementation[All Fields] AND ("resistance training"[MeSH Terms] OR ("resistance"[All Fields] AND "training"[All Fields]) OR "resistance training"[All Fields]) AND ("muscles"[MeSH Terms] OR "muscles"[All Fields] OR "muscle"[All Fields]) AND biceps[All Fields] AND triceps[All Fields] AND curl[All Fields] AND ("leg"[MeSH Terms] OR "leg"[All Fields]) AND curl[All Fields]
whey protein - supplementation - resistance training - energy - protein - intake	("whey proteins"[MeSH Terms] OR ("whey"[All Fields] AND "proteins"[All Fields]) OR "whey proteins"[All Fields] OR ("whey"[All Fields] AND "protein"[All Fields]) OR "whey protein"[All Fields]) AND supplementation[All Fields] AND ("resistance training"[MeSH Terms] OR ("resistance"[All Fields] AND "training"[All Fields]) OR "resistance training"[All Fields]) AND ("energy intake"[MeSH Terms] OR ("energy"[All Fields] AND "intake"[All Fields]) OR "energy intake"[All Fields]) AND ("proteins"[MeSH Terms] OR "proteins"[All Fields] OR "protein"[All Fields]) AND intake[All Fields]
whey protein - supplementation - resistance training - muscle strength - grip - squat	("whey proteins"[MeSH Terms] OR ("whey"[All Fields] AND "proteins"[All Fields]) OR "whey proteins"[All Fields] OR ("whey"[All Fields] AND "protein"[All Fields]) OR "whey protein"[All Fields]) AND supplementation[All Fields] AND ("resistance training"[MeSH Terms] OR ("resistance"[All Fields] AND "training"[All Fields]) OR "resistance training"[All Fields]) AND ("muscle strength"[MeSH Terms] OR ("muscle"[All Fields] AND "strength"[All Fields]) OR "muscle strength"[All Fields]) AND ("hand strength"[MeSH Terms] OR ("hand"[All Fields] AND "strength"[All Fields]) OR "hand strength"[All Fields] OR "grip"[All Fields]) AND squat[All Fields]