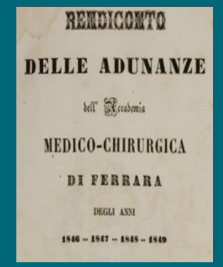
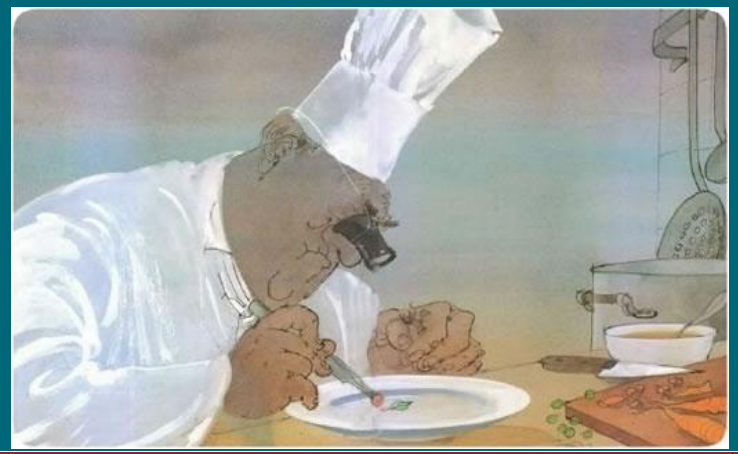
Società Medico Chirurgica di Ferrara

Ferrara 31 ottobre 2026



OBESITÀ ED ESERCIZIO FISICO



Silvia Migliaccio

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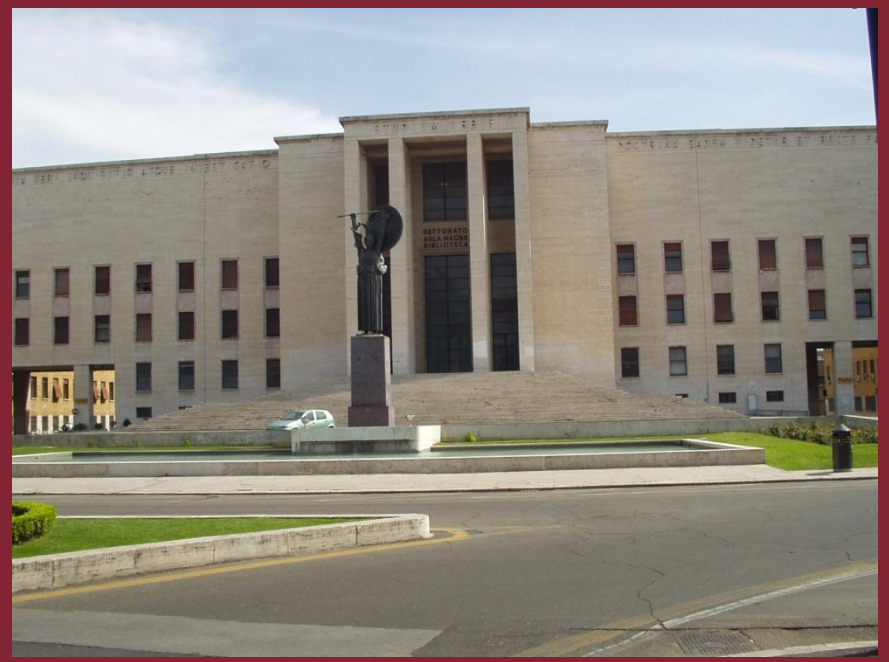
Dipartimento di Medicina Sperimentale

Sezione di Endocrinologia e Scienza dell'Alimentazione



silvia.migliaccio@uniroma1.it

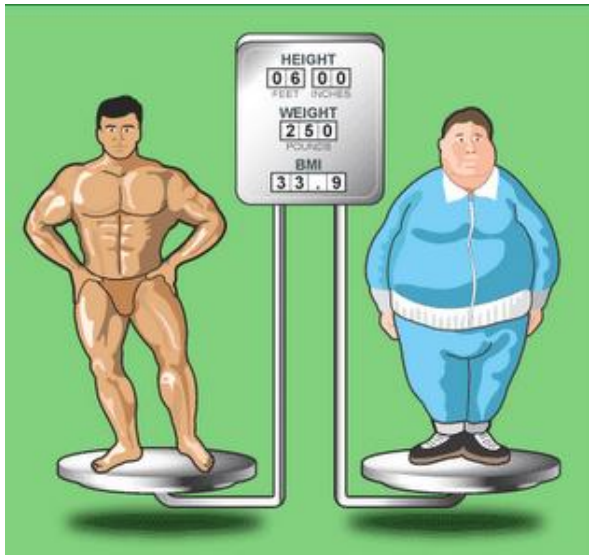
OBESITA’

L'**obesità** è una malattia cronica complessa e multisistemica caratterizzata da un eccessivo accumulo di grasso corporeo (tessuto adiposo >35% nelle donne >25% negli uomini) in relazione alla massa magra, tale da compromettere lo stato di salute e ridurre l'aspettativa di vita.



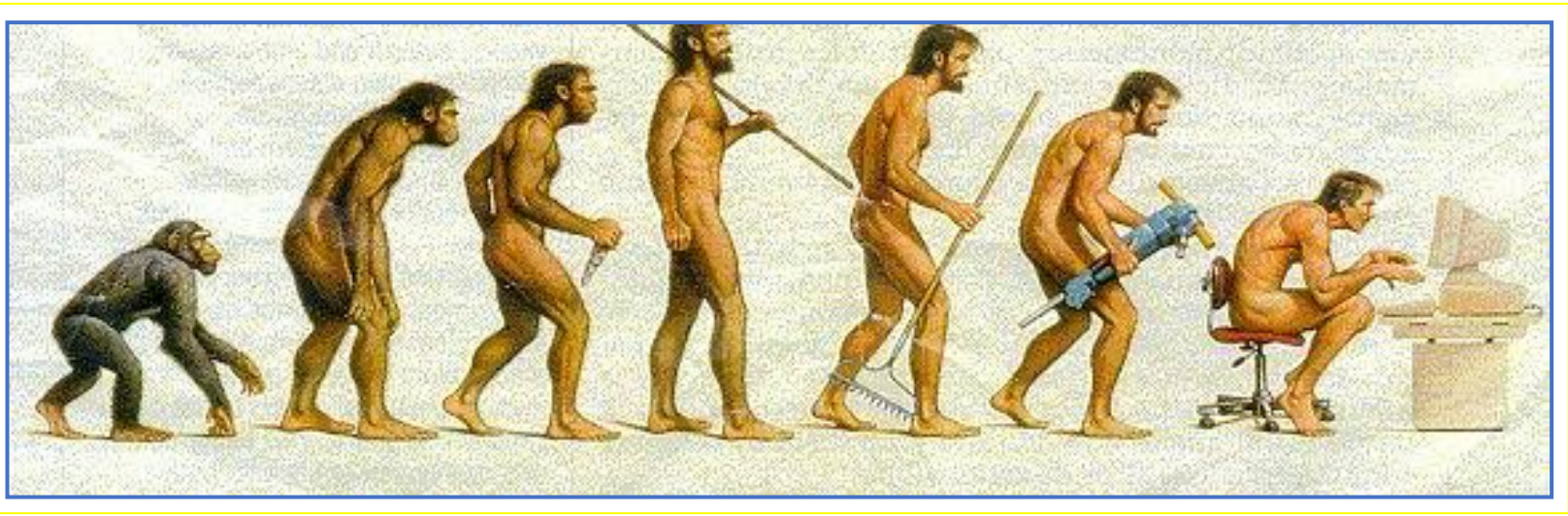


$$IMC = \frac{\text{Peso (Kg)}}{\text{Altezza (m}^2\text{)}}$$



WHO – Physical Status - 1995

STILE DI VITA

















Il Concetto di Dieta e i Pilastri del Trattamento

Il concetto di dieta fu introdotto da Ippocrate di Cos nel IV secolo a.C. wcon il suo testo

“Regime di vita” “diaita”

Obesità ed esercizio fisico







Approccio multidisciplinare all'obesita



- Endocrinologo
- Fisiatra / Ortopedico
- Dietologo/ Nutrizionista
- Reumatologo/ Internista
- Radiologo
- Fisioterapista
- Psicologo
- Chinesiologo

⇨ D.Lgs n. 36 del 28/02/2021

Chinesiologo delle attività motorie preventive e adattate

«*(Art.41)* Per l'esercizio dell'attività professionale di chinesiologo delle attività motorie preventive e adattate è necessario il possesso della laurea magistrale in attività motorie preventive e adattate (LM-67). L'esercizio dell'attività professionale ha per oggetto:

a) La progettazione e l'attuazione di programmi di attività motoria finalizzati al raggiungimento e mantenimento delle migliori condizioni di benessere psicofisico per soggetti in varie fasce d'età e in diverse condizioni fisiche;
b) l'organizzazione e la pianificazione di particolari attività e di stili di vita finalizzati alla prevenzione delle malattie e al miglioramento della qualità della vita mediante l'esercizio fisico;
c) la prevenzione dei vizi posturali e il recupero funzionale post-riabilitazione finalizzato all'ottimizzazione dell'efficienza fisica;
d) la programmazione, il coordinamento e la valutazione di attività motorie adattate in persone diversamente abili o in individui in condizioni di salute clinicamente controllate e stabilizzate.

SEDENTARIETÀ

la non pratica di un'attività fisica per un tempo uguale o inferiore a 3,5 ore la settimana

ATTIVITÀ FISICA

… qualsiasi forma di lavoro prodotta dalla muscolatura scheletrica che determini un dispendio energetico superiore a quello a riposo

ESERCIZIO FISICO

attività fisica caratterizzata da movimenti del corpo pianificati, strutturati, ripetitivi e intenzionali, svolti con l'obiettivo specifico di migliorare o mantenere componenti della forma fisica e della salute generale

1 World Health Organization. Regional Office for Europe, Physical Activity and health in Europe: evidence for action. 2006; 2 European guidelines on cardiovascular disease prevention in clinical practice: executive summary. 4th Joint Task Force of the European Society of Cardiology and other Societes on cardiovascular disease prevention in clinical practice. In: Eur J Cardiovasc Prev Rehabil 2004:14(s2).

BILANCIO ENERGETICO

2000 kcal

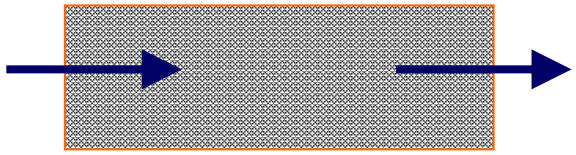
ENTRATE

ALIMENTI

ENERGIA

CALORIE

SISTEMA CHIUSO



2000 kcal

USCITE

- Metabolismo basale (60-70%)
- Potere termogenico degli alimenti (7-15%)
- Spese varie (20-30%) attivita' fisica

Maggiori necessità in:
Gravidanza / Allattamento
Accrescimento

Hernández-Reyes et al. BMC Women's Health (2019) 19:167
https://doi.org/10.1186/s12905-019-0864-5

BMC Women's Health

RESEARCH ARTICLE Open Access

Changes in body composition with a hypocaloric diet combined with sedentary, moderate and high-intense physical activity: a randomized controlled trial

A. Hernández-Reyes[1*], F. Cámara-Martos[1], R. Molina-Luque[2], M. Romero-Saldaña[3], G. Molina-Recio[2] and R. Moreno-Rojas[1]

Abstract

Background: There is evidence showing the effectiveness of a hypocaloric diet and the increase in physical activity on weight loss. However, the combined role of these factors, not only on weight loss but also body composition, remains unclear. The purpose of this study was to investigate the effect of a hypocaloric diet on the body composition of obese adult women throughout different degrees of physical activity during a weight loss program.

Methods: One hundred and seventeen healthy female volunteers were randomly assigned to one of the experimental groups: a control group with a low-level prescription of physical activity (1–4 METs), moderate physical activity group that performed 10.000 steps walking (5–8 METs) and intense physical activity group that trained exercises by at least 70% of VO2max three times a week (> 8 METs). All subjects followed a hypocaloric diet designed with a reduction of 500 kcal/day. Nutritional counseling was provided throughout the study period to help ensure dietary adherence.

Results: We found no differences in body weight compared to moderate and intense physical activity (ßstand. = − 0.138 vs. ßstand. = − 0.139). Body fat was lower in women following an intense activity (ßstand. = − 0.436) than those with moderate exercise (ßstand. = − 0.231). The high-intense activity also increased muscle mass at the end of the intervention, standing out above the moderate activity (ßstand. = 0.182 vs. ßstand. = 0.008).

Conclusions: These findings indicate that a hypocaloric diet, without prescription of physical activity, is adequate to lose weight in the short term (12 weeks), but physical activity is vital to modify the body composition in women with obesity. Body fat was lower when women practiced a moderate exercise compared to hypocaloric diet only, but an intense physical activity was the most effective protocol to obtain a reduction of body fat and maintain muscle mass.

Trial registration: The study protocol complied with the Declaration of Helsinki for medical studies, it was approved by the bioethical committee of Córdoba University, in the Department of Health at the Regional Government of Andalusia (Act n°284, ref.4156) and retrospectively registered in clinicaltrials.gov (NCT03833791). Registered 2 January 2019.

Keywords: Motivation, Weight-related goals, Physical activity, Hypocaloric diet, Weight-loss, Aerobic exercise, Dietary adherence

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Changes in body composition with diet and physical activity

Table 1 Participant characteristics at baseline

Characteristic	Overall (n = 60)(±SD)	Sedentary (n = 21)(±SD)	Moderate (n = 19)(±SD)	Intense (n = 20)(±SD)	*P*-value
Age, years	42.97 ± 10.84	46.10 ± 10.57	41.95 ± 12.47	40.65 ± 9.09	0.246
Height, cm	1.61 ± 0.07	1.62 ± 0.06	1.60 ± 0.07	1.61 ± 0.07	0.702
Weight, kg	82.56 ± 14.46	85.15 ± 15.03	82.75 ± 15.58	79.37 ± 12.84	0.413
BMI, kg/m^2	31.83 ± 5.32	32.65 ± 5.75	32.21 ± 4.95	30.60 ± 5.24	0.443
%BF	42.17 ± 5.50	42.35 ± 5.46	42.58 ± 4.55	41.59 ± 6.52	0.844
MM, kg	44.71 ± 5.08	46.07 ± 5.16	44.50 ± 5.18	43.49 ± 4.80	0.267
%W	43.11 ± 3.87	42.81 ± 3.75	42.78 ± 2.87	43.72 ± 482	0.693

Table 3 Changes in body measurements at 6 months

Characteristic	Sedentary (n = 21)(±SD)	Moderate (n = 19)(±SD)	Intense (n = 20)(±SD)	*P*-value
Age, years	-6.32 ± 2.68	-10.49 ± 2.52	-10.10 ± 3.93	<0.001*
BMI, kg/m^2	-6.16 ± 2.43	-9.55 ± 3.97	-10.10 ± 6.39	<0.001*
%BF	- 3.56 ± 3.13	-10.57 ± 3.45	-16.31 ± 5.91	<0.001*
MM	-3.66 ± 2.19	-3.23 ± 1.97	0.99 ± 4.96	<0.001*
%W	2.56 ± 2.19	6.49 ± 3.16	10.46 ± 6.32	<0.001*

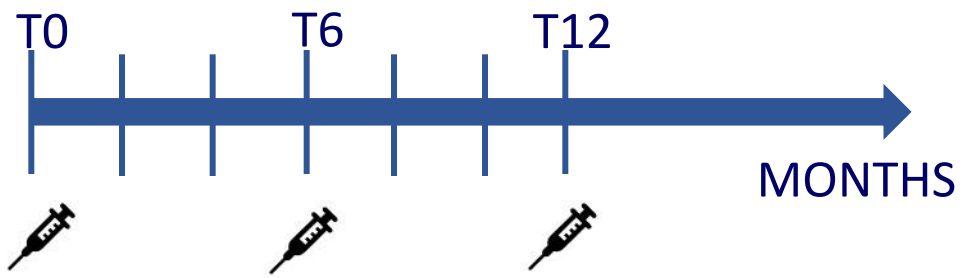
Importanza della prescrizione individualizzata dell'esercizio fisico

L'obesità comporta una eterogeneità nei diversi livelli di fitness con la conseguente impossibilità di applicare un protocollo unico di esercizio fisico adatto a tutti i soggetti.

I bassi livelli di fitness e le problematiche tipiche dell'obesità devono spingere gli specialisti in scienze motorie a pianificare l'allenamento sulla base delle capacità fisiche dei soggetti.

Evaluation of patients

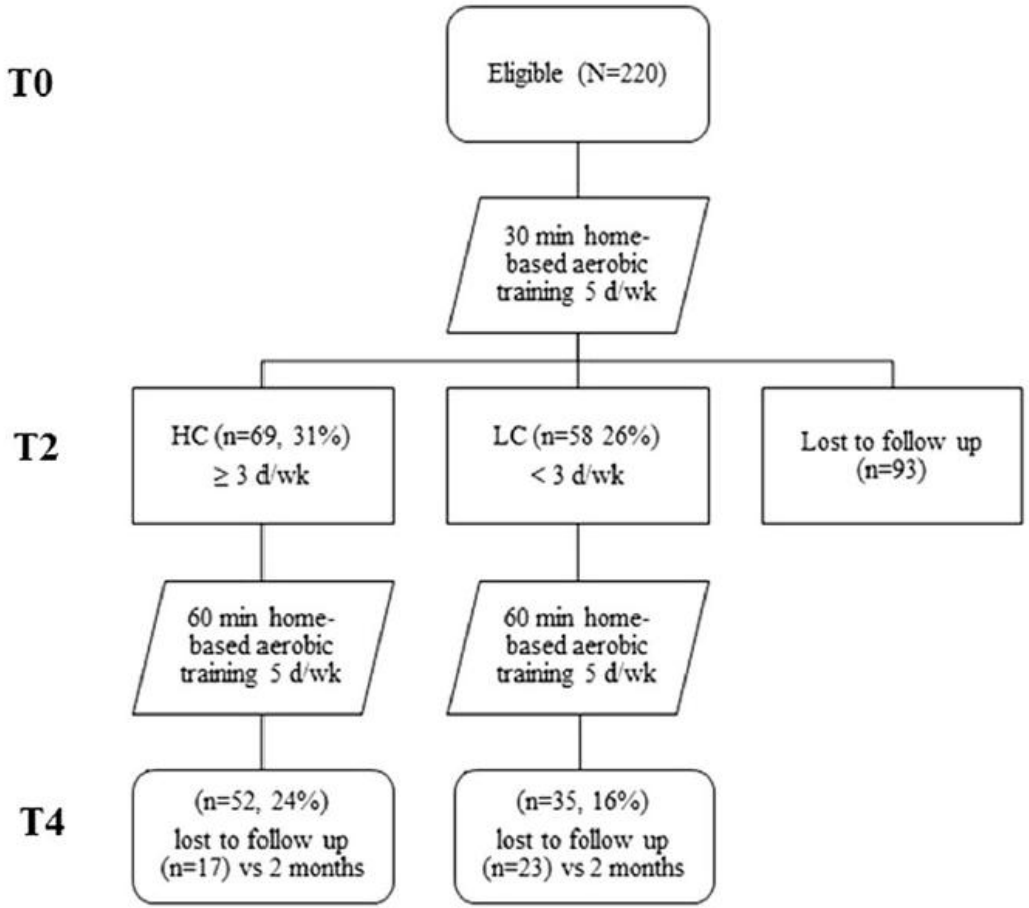
- ***Clinical evaluation*** (medical history, examination, anthropometric measurements)
- ***Body composition*** assessment (muscle and fat mass) by BIA and ***bone density*** and ***quality*** evaluation by DXA
- ***Nutritional evaluation*** and balanced hypocaloric diet prescription
- ***Functional assessment*** (treadmill test for % VO2 max,% HR max,% HRR, aerobic and anaerobic threshold) and physical activity prescription at Department of Movement, Human and Health Sciences, Section of Health Sciences, Foro Italico University, Rome, Italy
- ***Biochemical assessment*** (hematochemical routine, hormonal profile, cytokines levels)



J Endocrinol Invest
DOI 10.1007/s40618-017-0771-2

Effects of an individualized home-based unsupervised aerobic training on body composition and physiological parameters in obese adults are independent of gender

G. P. Emerenziani[1] · M. C. Gallotta[2] · S. Migliaccio[2] · D. Ferrari[2] · E. A. Greco[3] · F. J. Saavedra[4] · S. Iazzoni[2] · A. Aversa[1] · L. M. Donini[3] · A. Lenzi[3] · C. Baldari[2] · L. Guidetti[2]



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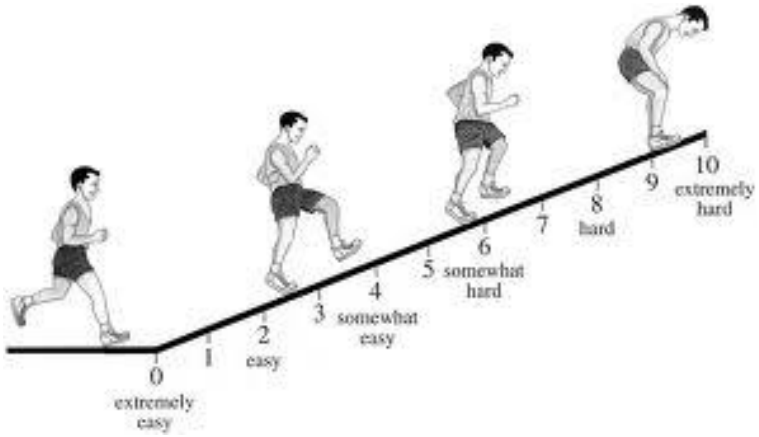
Valutazione delle soglie





TEST INCREMENTALE SUB MASSIMALE (RPE=10 o HR=85% HR_{max})





J Endocrinol Invest (2018) 41:465–473
https://doi.org/10.1007/s40618-017-0771-2

ORIGINAL ARTICLE

Effects of an individualized home-based unsupervised aerobic training on body composition and physiological parameters in obese adults are independent of gender

G. P. Emerenziani[1] · M. C. Gallotta[2] · S. Migliaccio[2] · D. Ferrari[2] · E. A. Greco[3] · F. J. Saavedra[4] · S. Iazzoni[2] · A. Aversa[1] · L. M. Donini[3] · A. Lenzi[3] · C. Baldari[2] · L. Guidetti[2]

Table 2 Anthropometric characteristics baseline and after intervention

	HC ($n = 52$)			LC ($n = 35$)		
	T0	T2	T4	T0	T2	T4
Weight (kg)	101.3 ± 21.4	97.31 ± 20.5**	94.2 ± 18.3**[a]	95.1 ± 20.7	94.7 ± 20.7	95.7 ± 20.8
BMI (kg/m^2)	37.6 ± 6.5	36.1 ± 6.4**	34.9 ± 5.7**[a]	35.4 ± 5.7	35.3 ± 5.6	35.6 ± 5.6
FFM (kg)	59.2 ± 12.6	59.3 ± 12.9	58.5 ± 12.5	54.4 ± 12.6	55.4 ± 14.0	55.0 ± 12.5
FFM (%)	57.3 ± 7.9	59.0 ± 6.7**	59.9 ± 7.2**[b]	57.6 ± 5.6	58.3 ± 6.1	57.5 ± 6.2
FM (%)	42.7 ± 6.5	41.0 ± 6.3**	40.1 ± 6.8**[a]	42.4 ± 5.4	41.7 ± 5.8	42.5 ± 5.8

BMI body mass index, *FFM* fat-free mass, *FM* fat mass

**$p < 0.01$ vs. T0

[a]$p < 0.01$ vs. T2

[b]$p < 0.05$ vs. T2

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Sapienza Università di Roma

J Endocrinol Invest (2018) 41:465–473
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ORIGINAL ARTICLE

Effects of an individualized home-based unsupervised aerobic training on body composition and physiological parameters in obese adults are independent of gender

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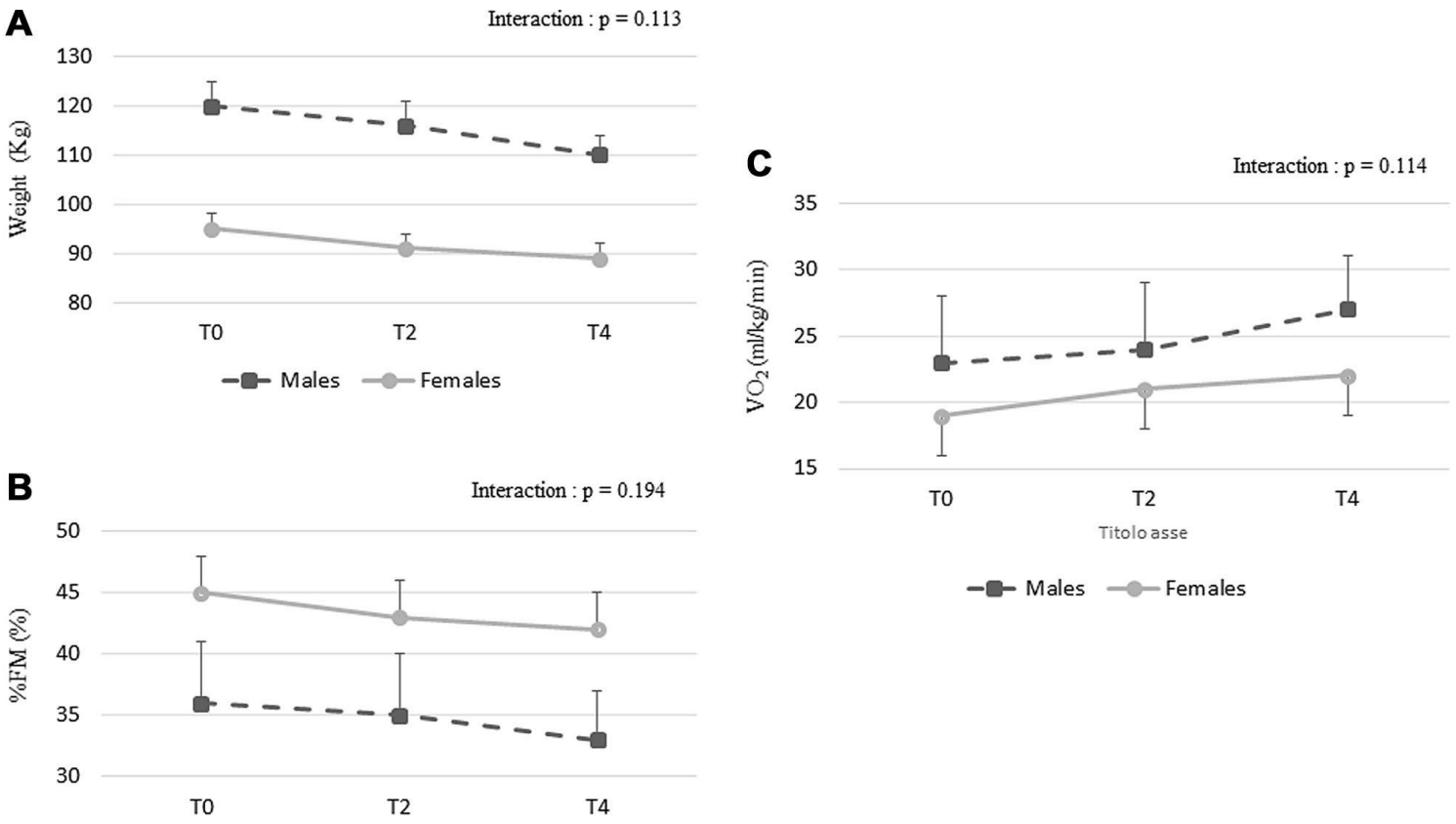

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Obes Rev. Author manuscript; available in PMC 2015 April 01.

Published in final edited form as:
Obes Rev. 2014 April ; 15(4): 310–321. doi:10.1111/obr.12143.

Weight Loss Composition is One-Fourth Fat-Free Mass: A Critical Review and Critique of This Widely Cited Rule

Steven B. Heymsfield[1], **M. C. Cristina Gonzalez**[2], **Wei Shen**[3], **Leanne Redman**[1], and **Diana Thomas**[4]

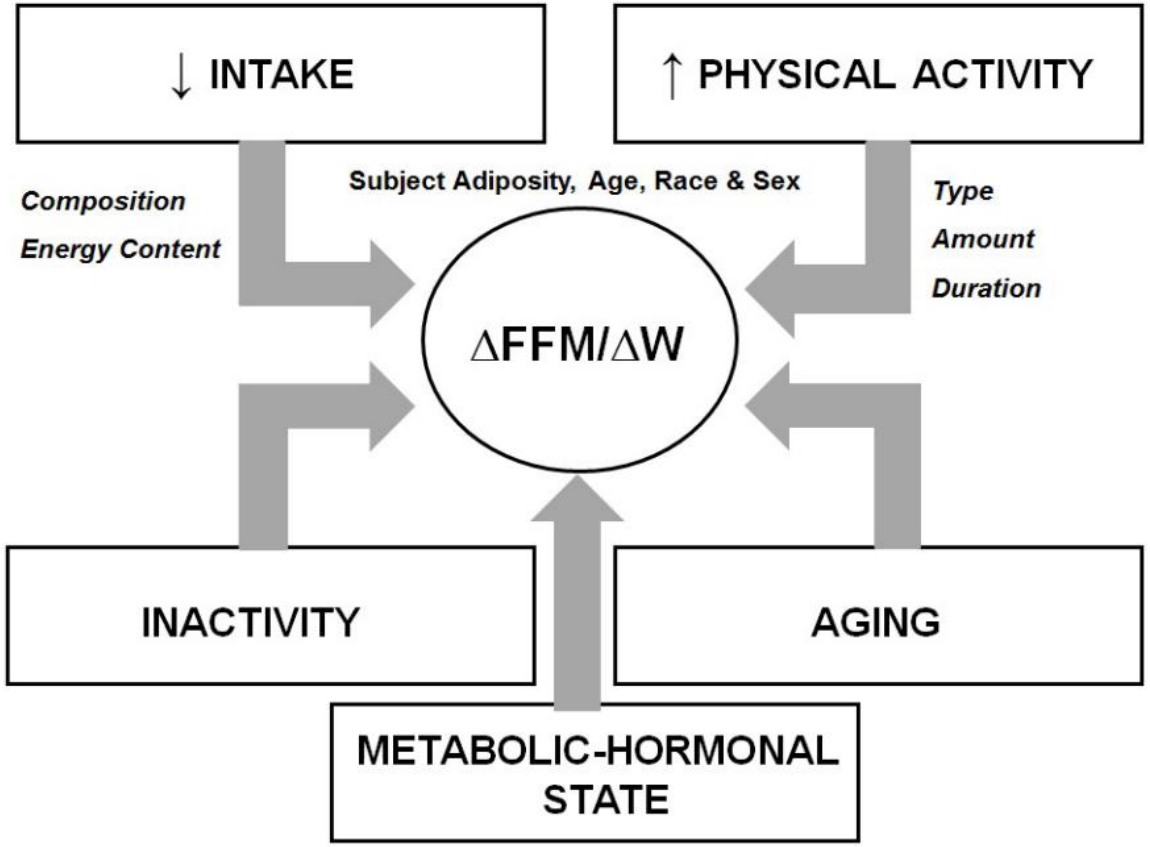
[1]Pennington Biomedical Research Center, Baton Rouge, LA, USA

[2]Post Graduate Program in Health and Behavior, Catholic University of Pelotas, Pelotas, RS, Brazil

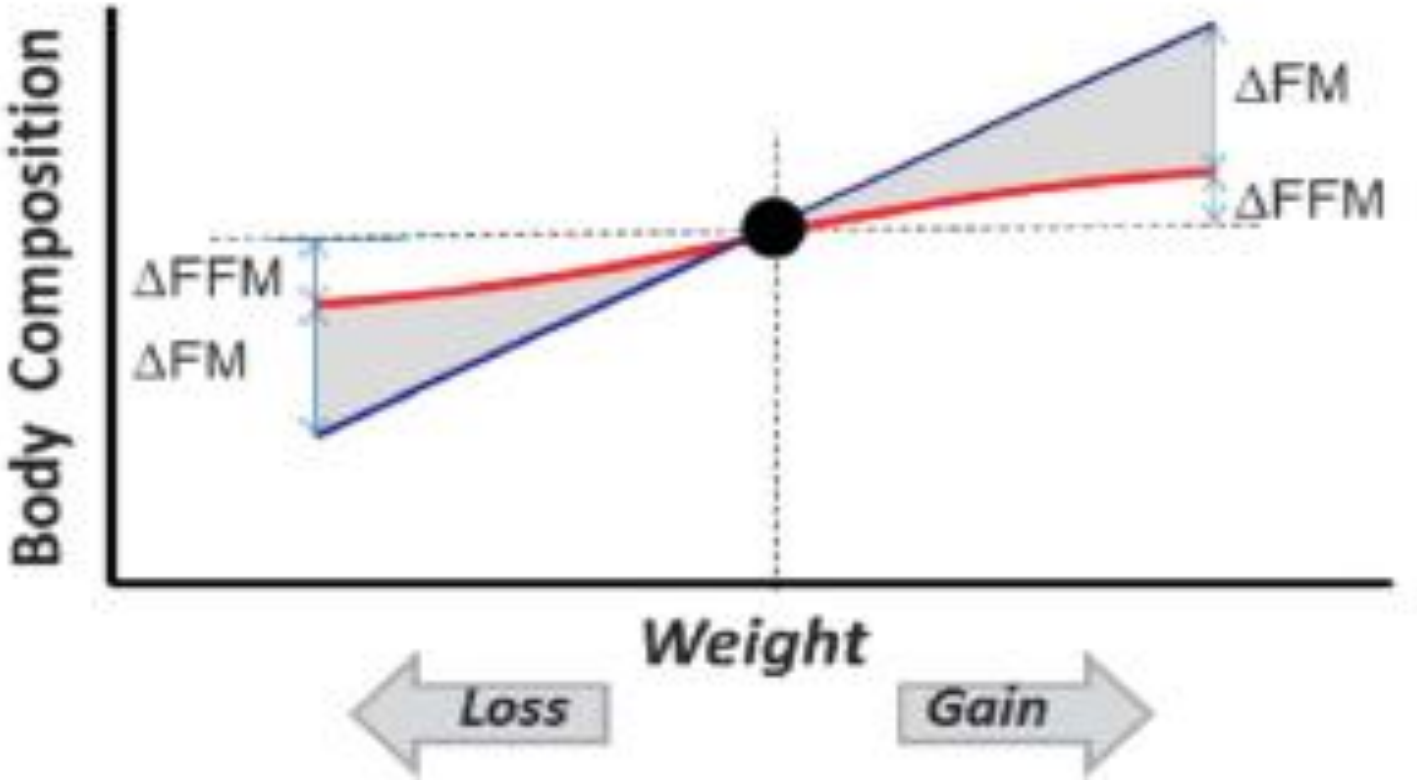
[3]New York Obesity Research Center, St. Luke's-Roosevelt Hospital, Columbia University, College of Physicians and Surgeons, NY, NY, USA

[4]Department of Mathematical Sciences, Montclair State University, Montclair, NJ, USA

Maximizing fat loss while preserving lean tissue mass and function is a central goal of modern obesity treatments. A widely cited rule guiding expected loss of lean tissue as fat-free mass (FFM states that approximately one-fourth of weight loss will be FFM (i.e., ΔFFM/ΔWeight = ~0.25) with the remaining three-fourths fat mass. This review examines the dynamic relations between FFM, fat mass, and weight changes that follow induction of negative energy balance with hypocaloric dieting and/or exercise. Historical developments in the field are traced with the "Quarter FFM Rule" used as a framework to examine evolving concepts on obesity tissue, excess weight, and what is often cited as "Forbes' Rule". Temporal effects in the fractional contribution of FFM to changes in body weight are examined as are lean tissue moderating effects such as aging, inactivity, and exercise that frequently accompany structured low-calorie diet weight loss protocols. Losses of lean tissue with dieting typically tend to be small, raising questions about study design, power, and applied measurement method reliability. Our review elicits important questions related to the fractional loss of lean tissues with dieting and provides a foundation for future research on this topic.



«One-quarter rule»



European Journal of Clinical Nutrition (2017) 71, 353–357

Verreijen *et al. Nutrition Journal* (2017) 16:10
DOI 10.1186/s12937-017-0229-6

Nutrition Journal

RESEARCH Open Access

Effect of a high protein diet and/or resistance exercise on the preservation of fat free mass during weight loss in overweight and obese older adults: a randomized controlled trial

Amely M. Verreijen[1*], Mariëlle F. Engberink[1], Robert G. Memelink[1], Suzanne E. van der Plas[1], Marjolein Visser[2,3] and Peter J.M. Weijs[1,3]

Background: Intentional weight loss in obese older adults is a risk factor for accelerated muscle mass loss. We investigated whether a high protein diet and/or resistance exercise preserves fat free mass (FFM) during weight loss in overweight and obese older adults.

Methods: We included 100 overweight and obese adults (55–80 year) in a randomized controlled trial (RCT) with a 2 × 2 factorial design and intention-to-treat analysis. During a 10-week weight loss program all subjects followed a hypocaloric diet. Subjects were randomly allocated to either a high protein (1.3 g/kg body weight) or normal protein diet (0.8 g/kg), with or without a resistance exercise program 3 times/week. FFM was assessed by air displacement plethysmography.

Results: At baseline, mean (±SD) BMI was 32 ± 4 kg/m^2. During intervention, protein intake was 1.13 ± 0.35 g/kg in the high protein groups vs. 0.98 ± 0.29 in the normal protein groups, which reflects a 16.3 ± 5.2 g/d higher protein intake in the high protein groups. Both high protein diet and exercise did not significantly affect change in body weight, FFM and fat mass (FM). No significant protein*exercise interaction effect was observed for FFM. However, within-group analysis showed that high protein in combination with exercise significantly increased FFM (+0.6 ± 1.3 kg, $p = 0.011$).

Conclusion: A high protein diet, though lower than targeted, did not significantly affect changes in FFM during modest weight loss in older overweight and obese adults. There was no significant interaction between the high protein diet and resistance exercise for change in FFM. However, only the group with the combined intervention of high protein diet and resistance exercise significantly increased in FFM.

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The Journal of Sports Medicine and Physical Fitness 2019 April;59(4):624-31
DOI: 10.23736/S0022-4707.18.08578-X

Effects of body weight loss program on parameters of muscle performance in female obese adults

Gian Pietro EMERENZIANI [1], Dafne FERRARI [2], Silvia MIGLIACCIO [2], Andrea LENZI [3], Emanuela A. GRECO [3], Chiara MAROCCO [2], Carlo BALDARI [4] *, Laura GUIDETTI [2]

TABLE I.—*Significant differences in anthropometrics variables pre- and postintervention in both groups.*

Variables	LC group (N.=22)		ES	HC group (N.=14)		ES
	Pre	Post	d	Pre	Post	d
Weight (kg)	91.5±12.6	90.7±12.9	-0.06	98.2±12.0	92.6±11.1**	-0.37
BMI (kg·m^{-2})	36.1±5.0	35.8±5.0	-0.06	37.3±4.5	35.2±4.2**	-0.35
FM (%)	44.7±4.6	43.9±5.0	-0.17	45.5±4.1	43.6±4.9**	-0.34
FFM (kg)	50.1±4.3	50.5±4.5	0.07	53.1±4.4	51.8±3.8*	-0.29
FFM (%)	55.3±4.6	56.1±4.9*	0.19	54.4±4.1	56.4±4.9**	0.34

LC: low compliance group; HC: high compliance group; FM: fat mass; FFM: fat free mass. BMI: Body Mass Index; ES: effects size.
*P<0.05 *vs.* pre; **P<0.01 *vs.* pre.



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Endocrine (2014) 47:699–716
DOI 10.1007/s12020-014-0315-x

REVIEW

Treatment of body composition changes in obese and overweight older adults: insight into the phenotype of sarcopenic obesity

Eleonora Poggiogalle · Silvia Migliaccio · Andrea Lenzi · Lorenzo Maria Donini

Received: 21 January 2014 / Accepted: 21 May 2014 / Published online: 22 June 2014
© Springer Science+Business Media New York 2014

Abstract In recent years, mounting interest has been directed to sarcopenic obesity (SO), given the parallel increase of life expectancy and prevalence of obesity in Western countries. The phenotype of SO is characterized by the coexistence of excess fat mass and decreased muscle mass, leading to the impairment of physical performance. The aim of the present review was to summarize the impact of different treatment strategies contrasting body composition changes in older obese and overweight subjects, pro- interventions, exercise/physical activity, dietary interventions, and pharmacological treatment. Most of the studies were randomized, controlled. Sample size ranged from 12 to 439 subjects, and study duration varied from 6 weeks to 12 months. Weight loss based on diet combined with exercise seems to be the best strategy to adopt for treatment of phenotypic aspects of SO, improving metabolic consequences related to excess fat, preserving lean mass, and allowing functional recovery

Preserving Healthy Muscle during Weight Loss[1–3]

Edda Cava, Nai Chien Yeat, and Bettina Mittendorfer*
Center for Human Nutrition, Washington University School of Medicine, St. Louis, MO

ABSTRACT

Weight loss is the cornerstone of therapy for people with obesity because it can ameliorate or completely resolve the metabolic risk factors for diabetes, coronary artery disease, and obesity-associated cancers. The potential health benefits of diet-induced weight loss are thought to be compromised by the weight-loss–associated loss of lean body mass, which could increase the risk of sarcopenia (low muscle mass and impaired muscle function). The objective of this review is to provide an overview of what is known about weight-loss–induced muscle loss and its implications for overall physical function (e.g., ability to lift items, walk, and climb stairs). The currently available data in the literature show the following: *1*) compared with persons with normal weight, those with obesity have more muscle mass but poor muscle quality; *2*) diet-induced weight loss reduces muscle mass without adversely affecting muscle strength; *3*) weight loss improves global physical function, most likely because of reduced fat mass; *4*) high protein intake helps preserve lean body and muscle mass during weight loss but does not improve muscle strength and could have adverse effects on metabolic function; *5*) both endurance- and resistance-type exercise help preserve muscle mass during weight loss, and resistance-type exercise also improves muscle strength. We therefore conclude that weight-loss therapy, including a hypocaloric diet with adequate (but not excessive) protein intake and increased physical activity (particularly resistance-type exercise), should be promoted to maintain muscle mass and improve muscle strength and physical function in persons with obesity. *Adv Nutr* 2017;8:511–9.

Società Italiana di Scienze dell'Alimentazione
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metabolites ; 2026, 16, 761 MDPI

Article

Effects of Combined Aerobic and Resistance Exercise on Liver Metabolomics in Mice Fed a High-Fat Diet

Yefan Wang, Pengpeng Gao, Zijun Hao and Lijun Wu *

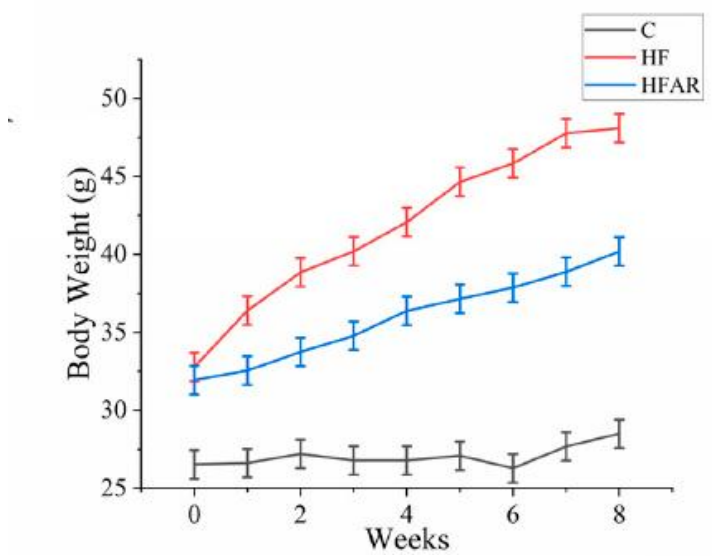
What are the main findings?

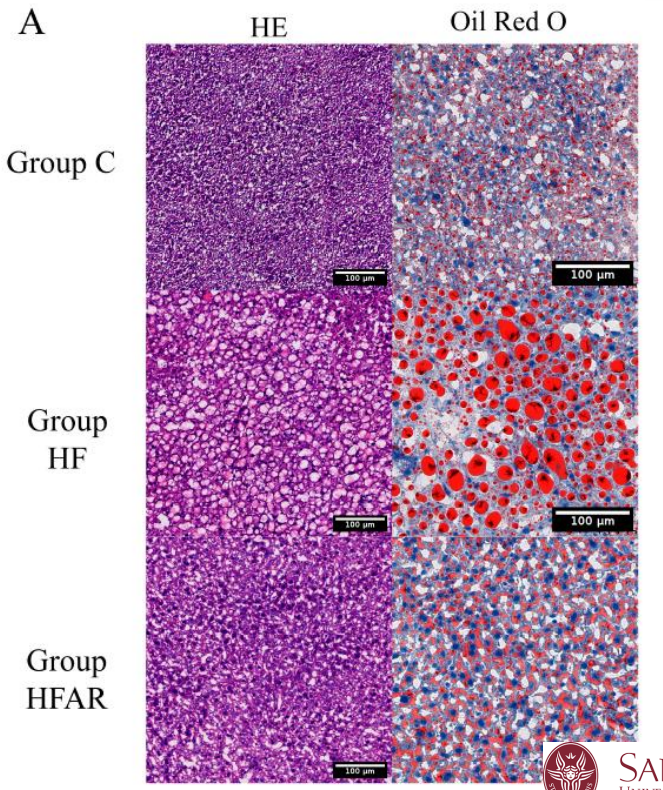
•An 8-week combined aerobic and resistance exercise intervention reduced steatosis, lipid accumulation, and inflammation in high-fat diet-induced obese mice, even without significant BW reduction.

•Untargeted metabolomics identified 6 potential Metabolites, with pathway enrichment analysis revealing histidine/pyrimidine metabolism linking exercise to improved hepatic lipid homeostasis and cellular repair.

What are the implications of the main findings?

•These findings provide metabolomic evidence that combined exercise remodels hepatic metabolic networks, offering mechanistic insights into how exercise protects against obesity-associated liver disease beyond weight loss.



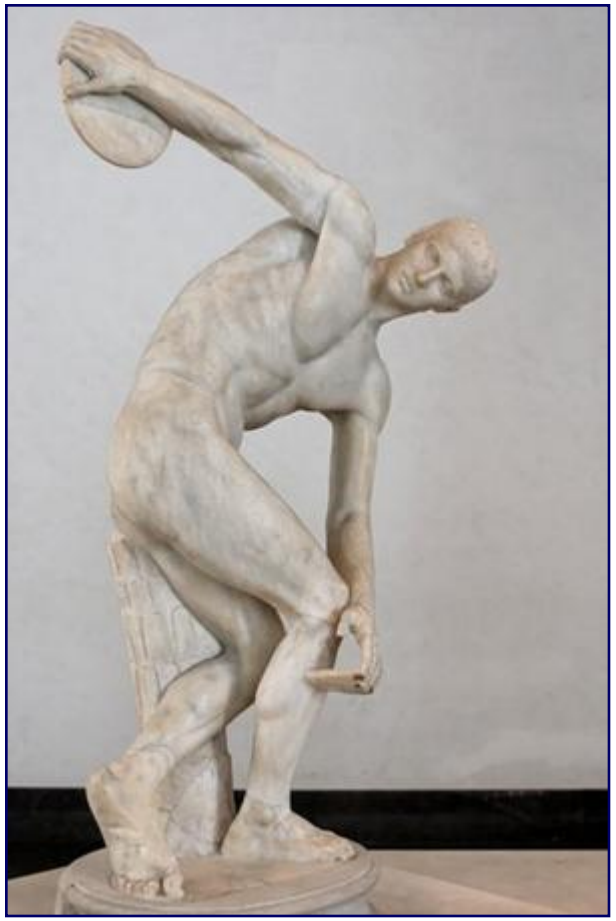


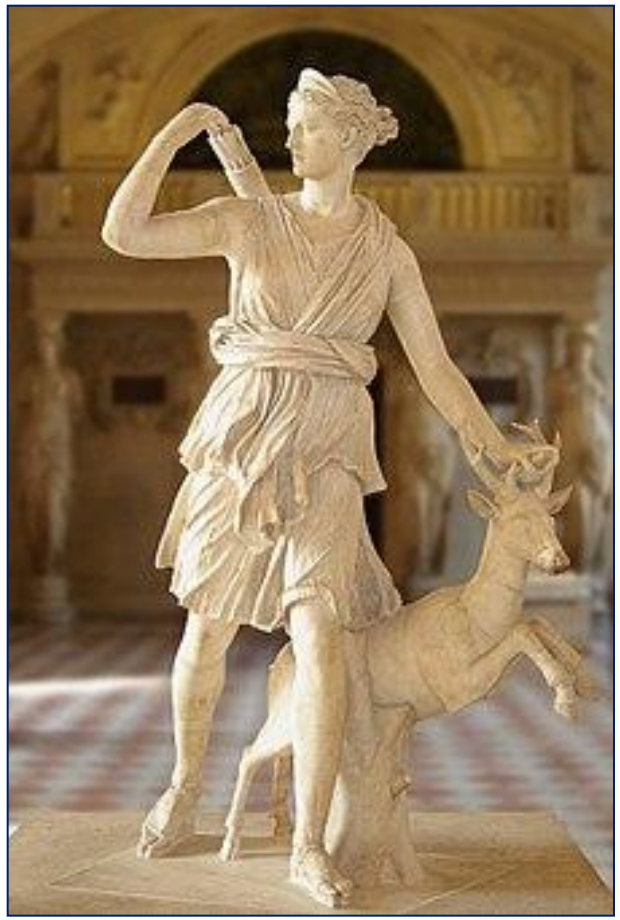
CONCLUSIONI

- ✓ Intervento gruppo interdisciplinare
- ✓ Integrazione di attività fisica e Dieta
- ✓ Personalizzazione dell'intervento nutrizionale
- ✓ Personalizzazione attività fisica lavorando alla soglia ventilatoria per almeno 3 ore alla settimana e integrando con attività di potenziamento
- ✓ Aderenza e Compliance sono fondamentali

Se fossimo in grado di fornire a ciascuno la giusta dose di nutrimento ed esercizio fisico, né in eccesso né in difetto, avremmo trovato la strada per la salute."

(Ippocrate, 460-377 a.C.).





New Pictorial Proposal for an Environmental, Sustainable Mediterranean Diet





IFMeD International Foundation of Mediterranean Diet
A healthy and sustainable Future

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Author: Scientific Advisory Committee of IFMeD
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SAPIENZA UNIVERSITÀ DI ROMA

Obesity A Research Journal

THE OBESITY SOCIETY

ORIGINAL ARTICLE

Proportion of caloric restriction-induced weight loss as skeletal muscle

Steven B. Heymsfield, Shengping Yang, Cassidy McCarthy, Jasmin B. Brown, Corby K. Martin, Leanne M. Redman, Eric Ravussin, Wei Shen, Manfred J. Müller, Anja Bosy-Westphal

First published: 08 October 2023 | https://doi.org/10.1002/oby.23910

Methods

The model development group included healthy nonexercising adults ($n = 897$) who had whole-body SM mass measured with magnetic resonance imaging. Model predictions of relative SM changes with CR were evaluated in two longitudinal studies, one 12 to 14 weeks in duration ($n = 74$) and the other 12 months in duration ($n = 26$).

Results

A series of SM prediction models were developed in a sample of 415 males and 482 females. Model-predicted changes in SM mass relative to changes in body weight (i.e., ΔSM/Δbody weight) with a representative model were (mean ± SE) 0.26 ± 0.013 in males and 0.14 ± 0.007 in females (sex difference, $p < 0.001$). The actual mean proportions of weight loss as SM in the longitudinal studies were 0.23 ± 0.02/0.20 ± 0.06 in males and 0.10 ± 0.02/0.17 ± 0.03 in females, similar to model-predicted values.

Conclusions

Nonelderly males and females with overweight and obesity experience respective reductions in SM mass with voluntary CR in the absence of a structured exercise prograr of about 2 to 2.5 kg and 1 to 1.5 kg per 10-kg weight loss, respectively. These estimates are predicted to be influenced by interactions between age and body mass index in males, a hypothesis that needs future testing.

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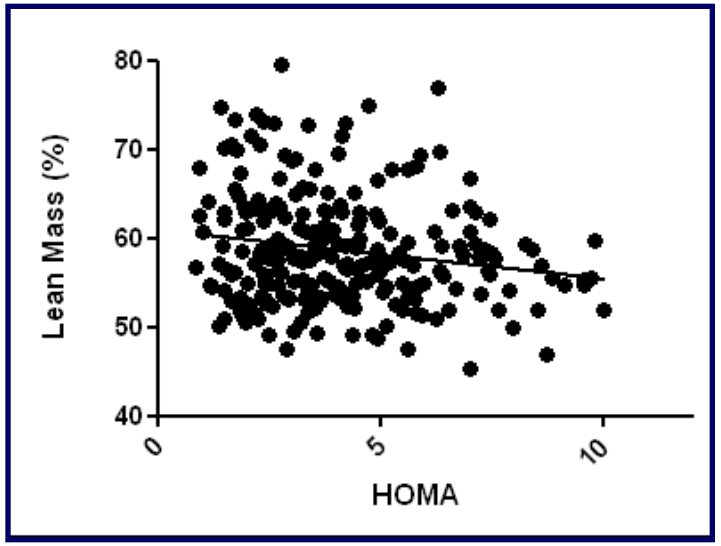
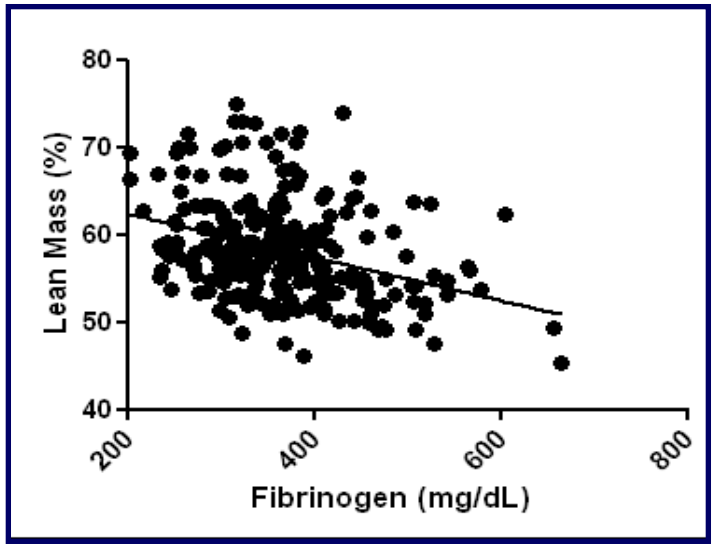
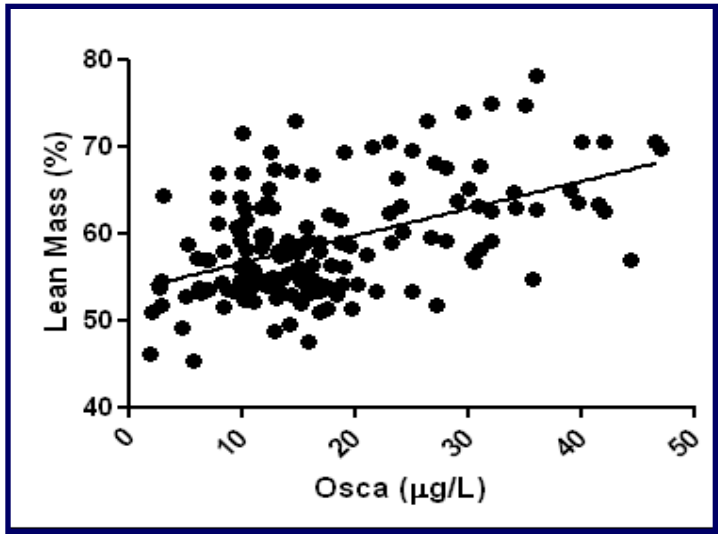
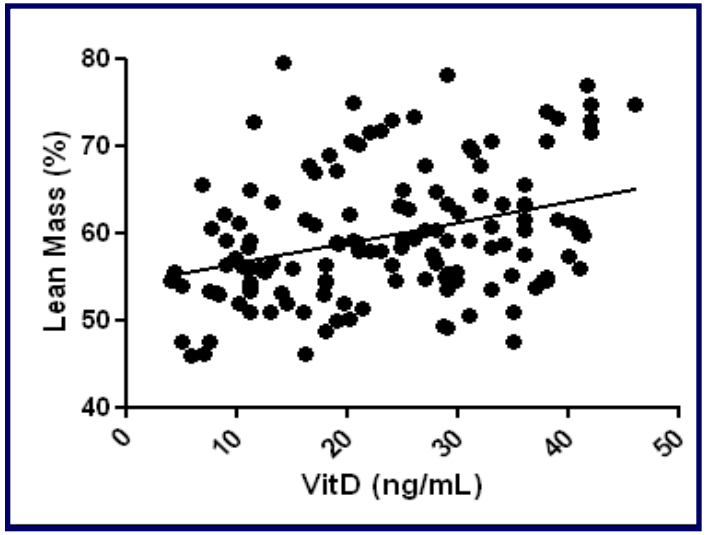
THE IMPORTANCE OF LEAN MASS









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Fornari, et al J Endocr Invest 2015; Fornari et al. Eat Weigh Disor 2017

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RACCOMANDAZIONI E CLASSIFICAZIONE DELL'INTENSITA' DELL'ESERCIZIO FISICO

- Low physical fitness: VO_{2peak} (< 15 -20 $ml*kg^{-1}min^{-1}$)
- Low exercise performance: Range of movements etc…
- Low strength

TABLE 5. Classification of exercise intensity: relative and absolute exercise intensity for cardiorespiratory endurance and resistance exercise.

	Cardiorespiratory Endurance Exercise							
	Relative Intensity				Intensity ($\%\dot{V}O_{2max}$) Relative to Maximal Exercise Capacity in METs			Absolute Intensity
Intensity	%HRR or $\%\dot{V}O_2R$	$\%HR_{max}$	$\%\dot{V}O_{2max}$	Perceived Exertion (Rating on 6–20 RPE Scale)	20 METs $\%\dot{V}O_{2max}$	10 METs $\%\dot{V}O_{2max}$	5 METs $\%\dot{V}O_{2max}$	METs
Very light	<30	<57	<37	<Very light (RPE < 9)	<34	<37	<44	<2
Light	30–39	57–63	37–45	Very light–fairly light (RPE 9–11)	34–42	37–45	44–51	2.0–2.9
Moderate	40–59	64–76	46–63	Fairly light to somewhat hard (RPE 12–13)	43–61	46–63	52–67	3.0 to 5.9
Vigorous	60–89	77–95	64–90	Somewhat hard to very hard (RPE 14–17)	62–90	64–90	68–91	6.0–8.7
Near–maximal to maximal	≥90	≥96	≥91	≥Very hard (RPE ≥ 18)	≥91	≥91	≥92	≥8.8

VO_2 max è un parametro biologico che esprime il volume massimo di ossigeno che un essere umano può consumare nell'unità di tempo per contrazione muscolare. The Metabolic Equivalent (MET) è un parametron fisiologico che esprime l'energia spesa facendo attività fisica (quantità di energia consumata)

Donnelly JE, et al. Med Sci Sports Exerc. 2009 ;41:459-71