Activity and Appetite in Children and Adolescents

Tehran (Online) – December 2020

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Energy Balance

Energy Balance

Acute Exercise?
Chronic Physical Activity?

Intervention:

At 11:00 am
cycling exercise
3 times 10 min
at 75% VO2max
(with 1 min and 30 s of rest between exercise bouts).

Thivel, D., Metz, L., Julien, A., Morio, B., & Duché, P. (2014). *Obese but not lean adolescents spontaneously decrease energy intake after intensive exercise. Physiology & Behavior, 123, 41–46.*

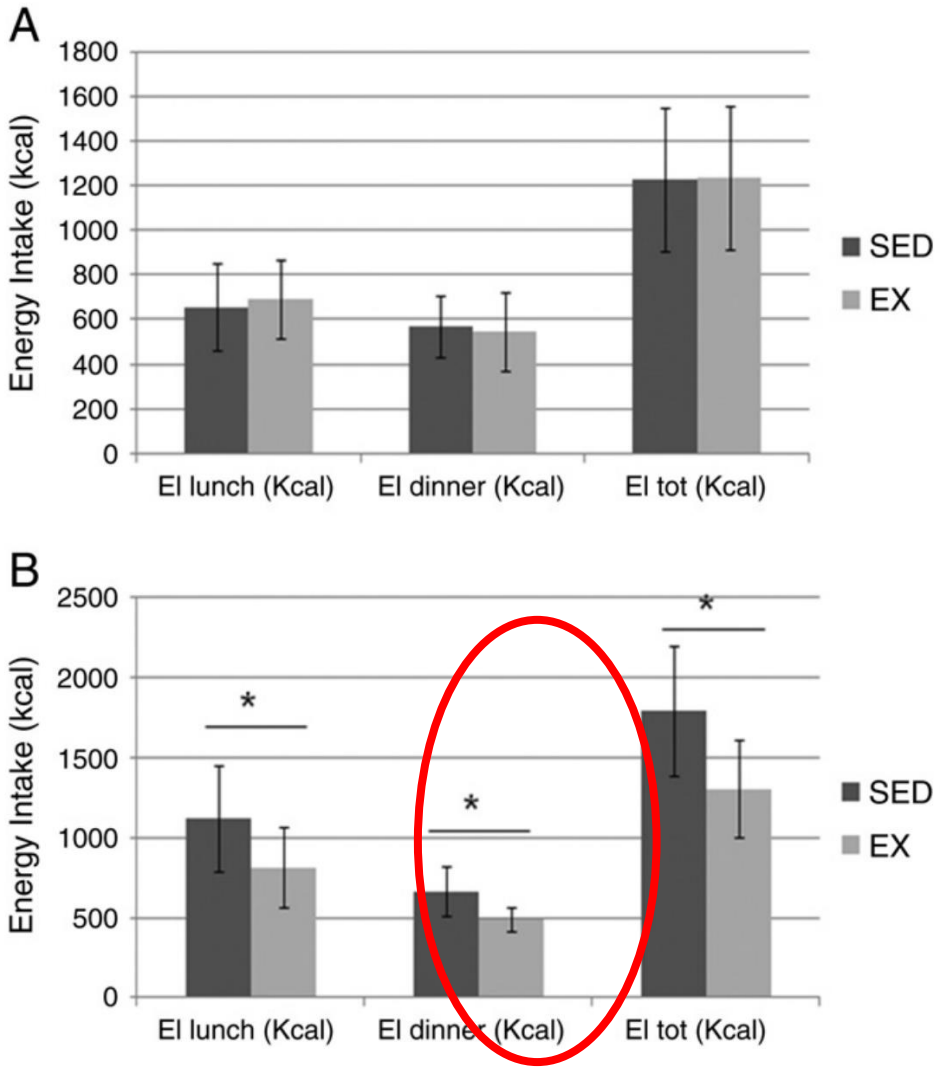


Fig. 1. Daily, lunch and dinner time energy intake in lean (A) and obese (B) adolescents during the sedentary (SED) and exercise (EX) conditions. (EI = Energy intake; *p < 0.05).

Intervention:

At 11:00am
a cycling exercise
LIE 40%VO2max, 60 Min
HIE 75%VO2max, 30 Min

The duration of each exercise was individually calculated so that LIE and HIE tests were isoenergetic for each participant (the targeted EE was approximately 1400 KJ).

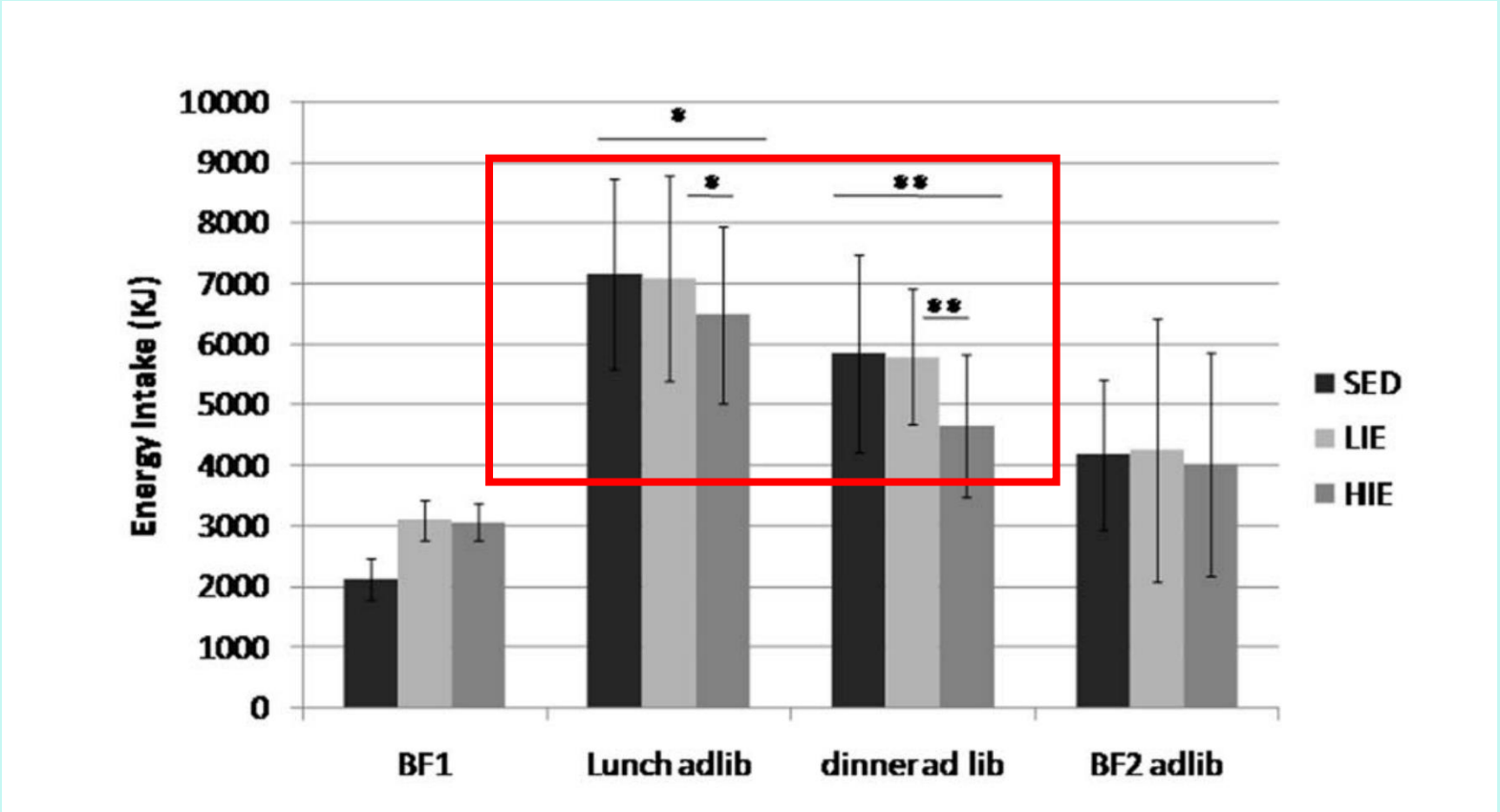


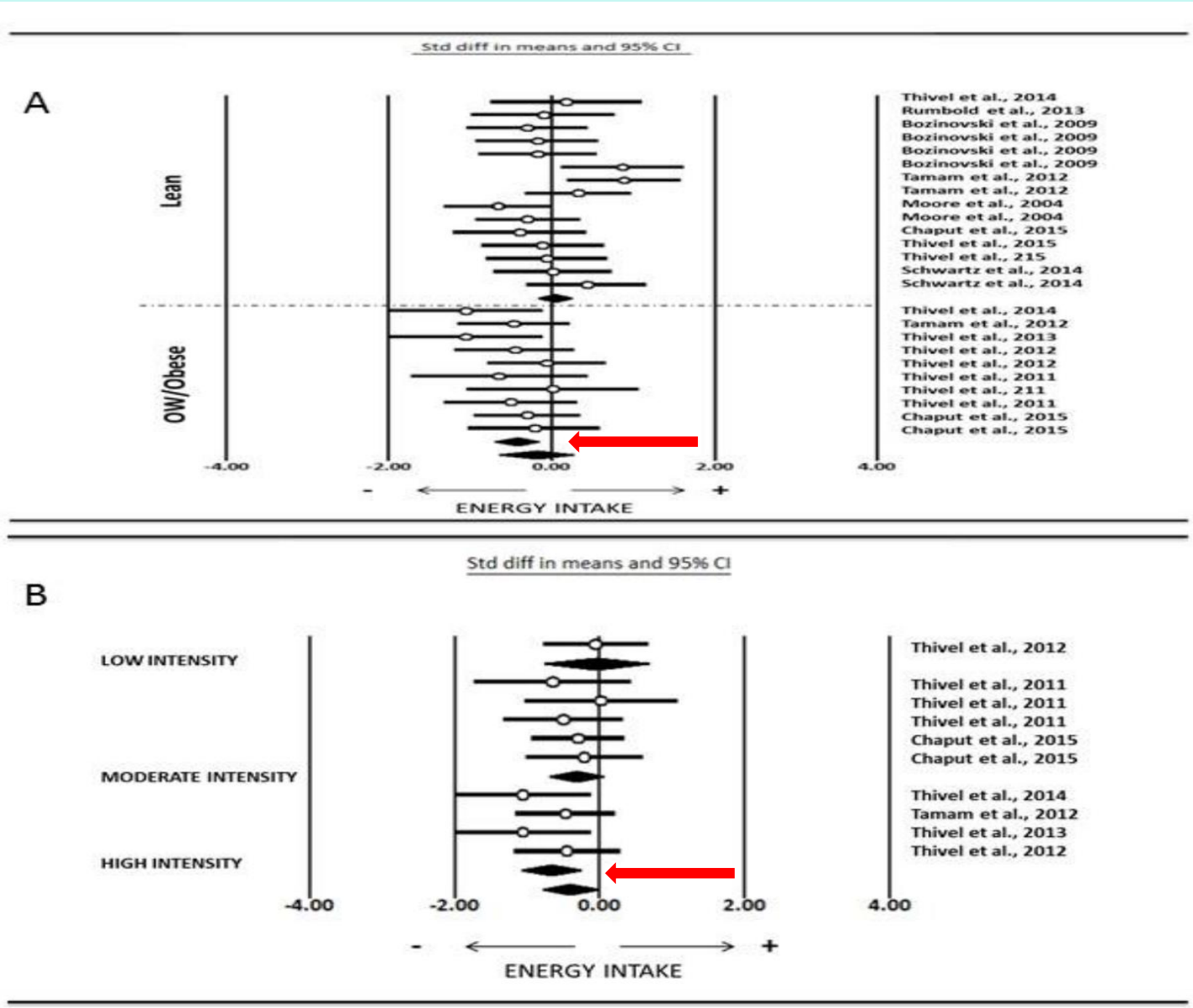
Figure 1. Energy consumption (KJ) distribution between meals for each experimental session (SED: sedentary; LIE: Low-Intensity Exercise; HIE: High-Intensity exercise). Breakfast on day 1 (BF1) was calibrated; lunch, dinner and BF2 (breakfast on day 2) were offered ad libitum (adlib).

Thivel, D., Isacco, L., Montaurier, C., Boirie, Y., Duché, P., & Morio, B. (2012). *The 24-h Energy Intake of Obese Adolescents Is Spontaneously Reduced after Intensive Exercise: A Randomized Controlled Trial in Calorimetric Chambers. PLoS ONE, 7(1),*

Figure 3. Subjective satiety feeling (Visual Analogue Scale of 100 mm) throughout the experimental sessions (SED: Sedentary; LIE: Low-Intensity Exercise; HIE: High-Intensity Exercise). BF1: calibrated breakfast on day 1; BF2: *ad libitum* breakfast on day 2.
doi:10.1371/journal.pone.0029840.g003

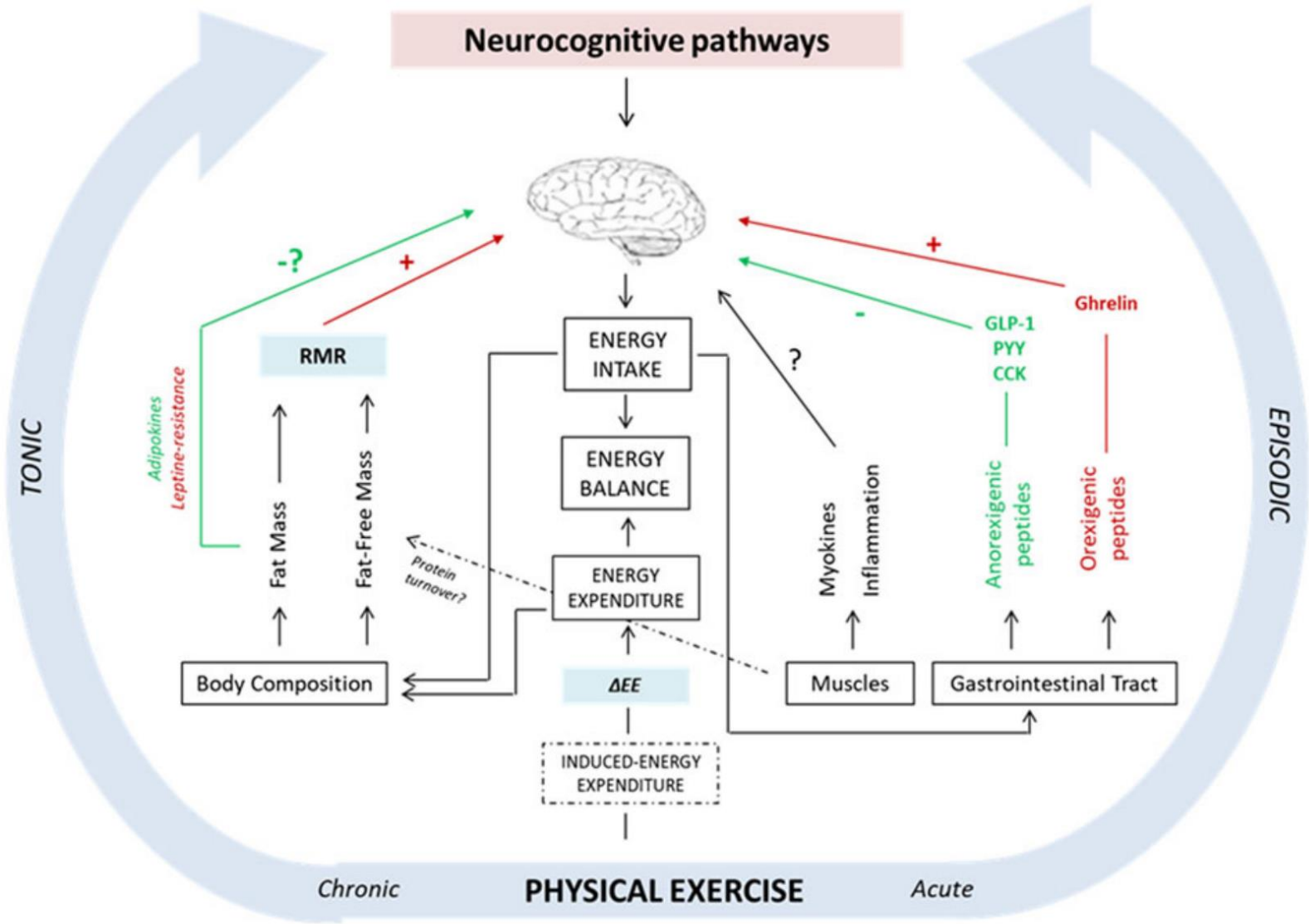
Thivel, D., Isacco, L., Montaurier, C., Boirie, Y., Duché, P., & Morio, B. (2012). *The 24-h Energy Intake of Obese Adolescents Is Spontaneously Reduced after Intensive Exercise: A Randomized Controlled Trial in Calorimetric Chambers. PLoS ONE, 7(1), e29840.* doi:10.1371/journal.pone.0029840

Figure 2. (A) Effect size forest plot for absolute energy intake in both lean and obese youth (mean ± 95% confidence intervals); (B) Effect size forest plot for absolute energy intake in obese youth, depending on the exercise intensity (mean ± 95% confidence intervals).



Thivel, D., Rumbold, P. L., King, N. A., Pereira, B., Blundell, J. E., & Mathieu, M.-E. (2016). *Acute post-exercise energy and macronutrient intake in lean and obese youth: a systematic review and meta-analysis. International Journal of Obesity, 40(10), 1469–1479.*

Thivel, D., Finlayson, G., & Blundell, J. E. (2018). *Homeostatic and neurocognitive control of energy intake in response to exercise in pediatric obesity: a psychobiological framework. Obesity Reviews.*



Schwartz, C., King, N. A., Perreira, B., Blundell, J. E., & Thivel, D. (2016). *A systematic review and meta-analysis of energy and macronutrient intake responses to physical activity interventions in children and adolescents with obesity. Pediatric Obesity, 12(3), 179–194.*

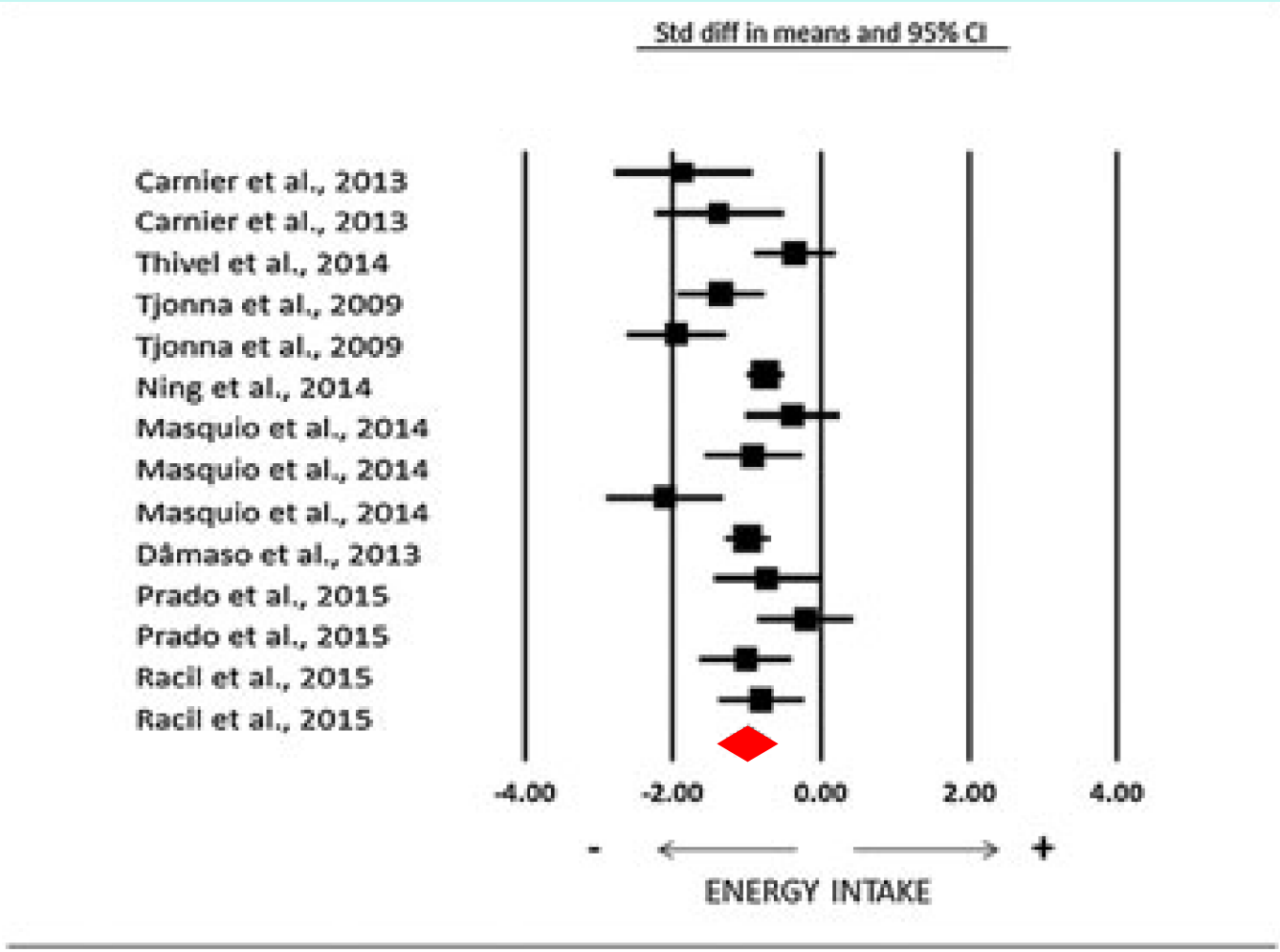


Figure 2 Effect size forest plot for absolute energy intake (mean ± 95% confidence intervals).

Self Reported

Secondary Outcome

No Evidence Regarding Appetite

No data on Appetite Regulating Factors

Schwartz, C., King, N. A., Perreira, B., Blundell, J. E., & Thivel, D. (2016). *A systematic review and meta-analysis of energy and macronutrient intake responses to physical activity interventions in children and adolescents with obesity. Pediatric Obesity, 12(3), 179–194.*

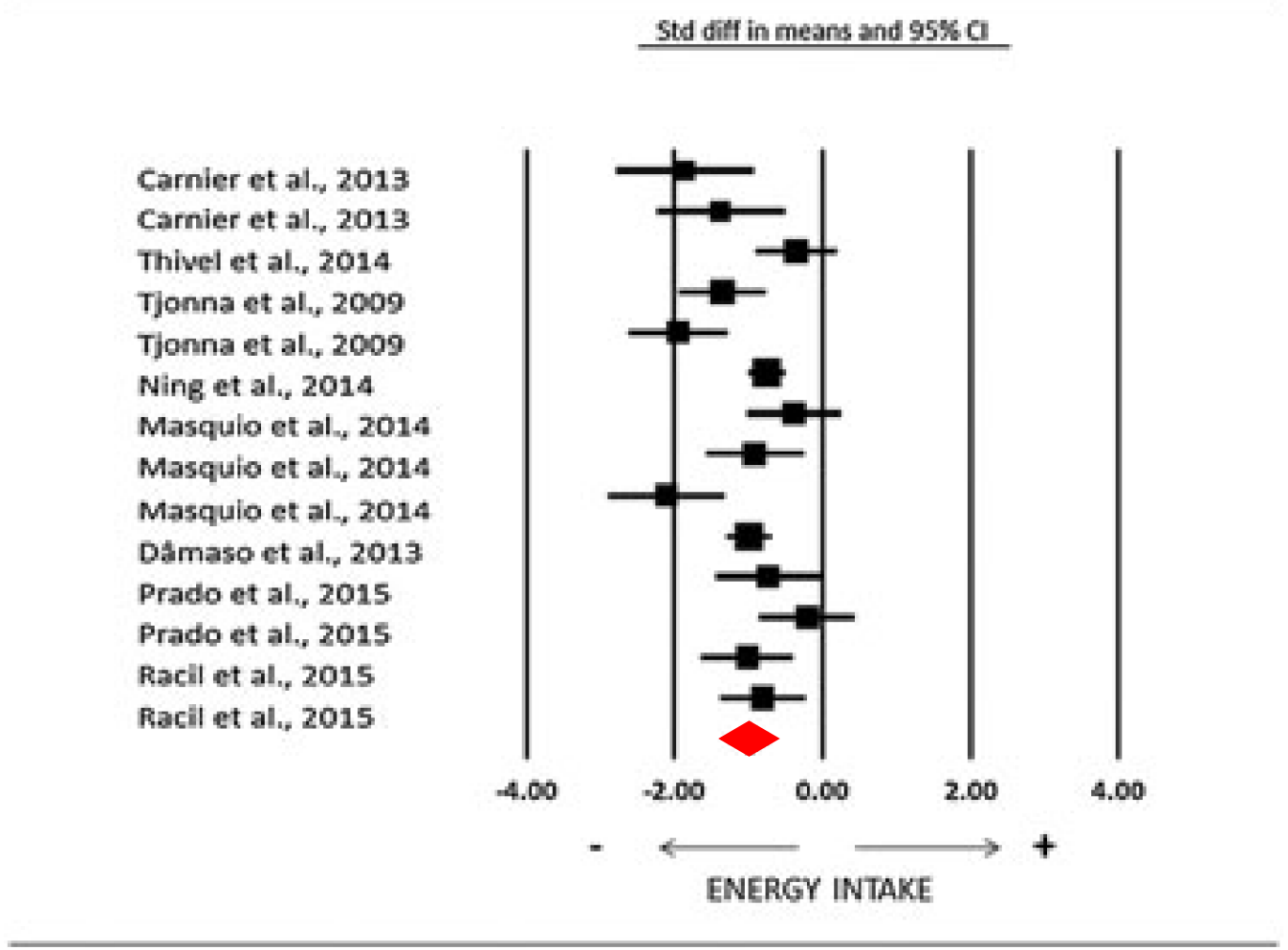
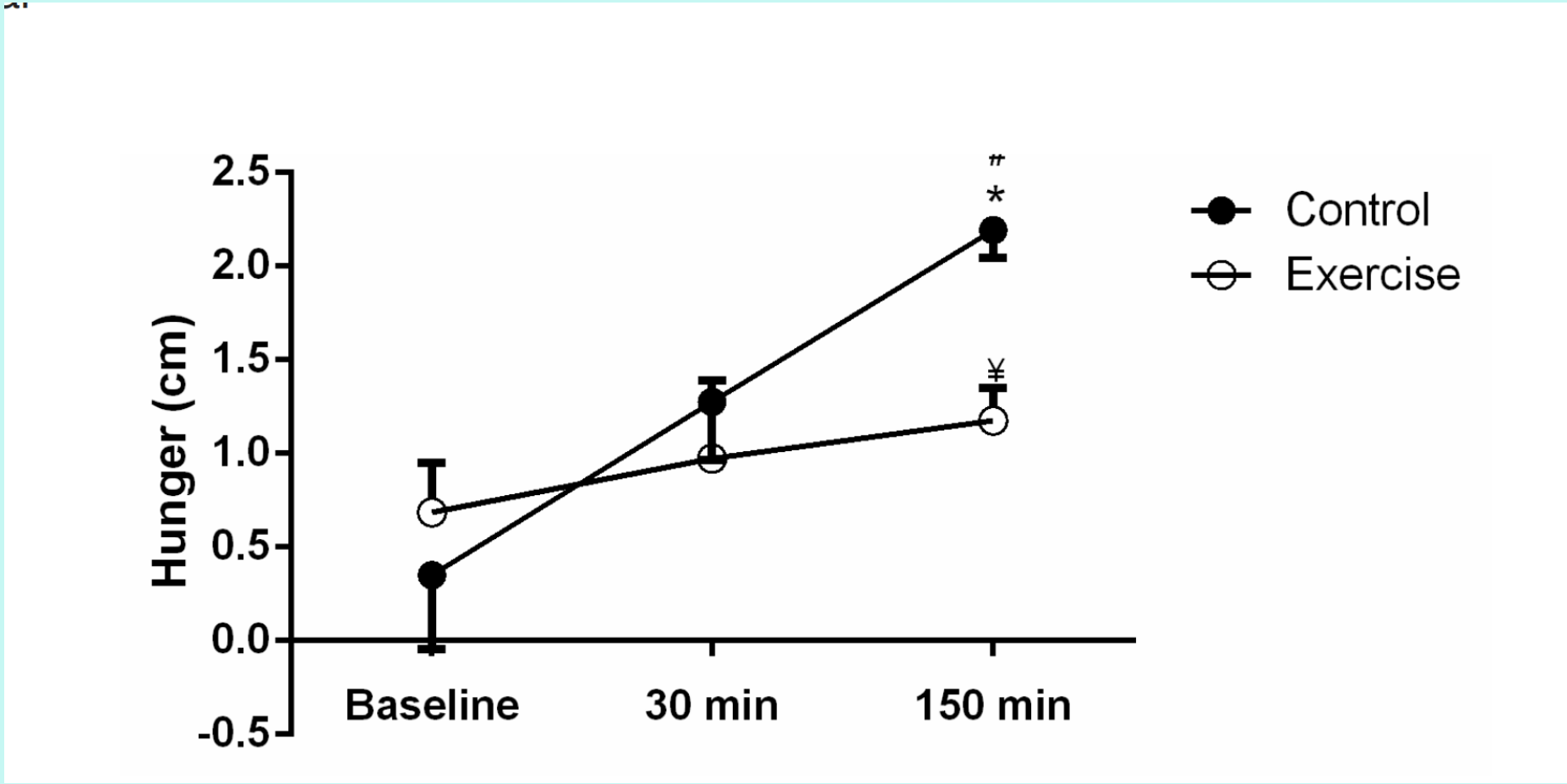
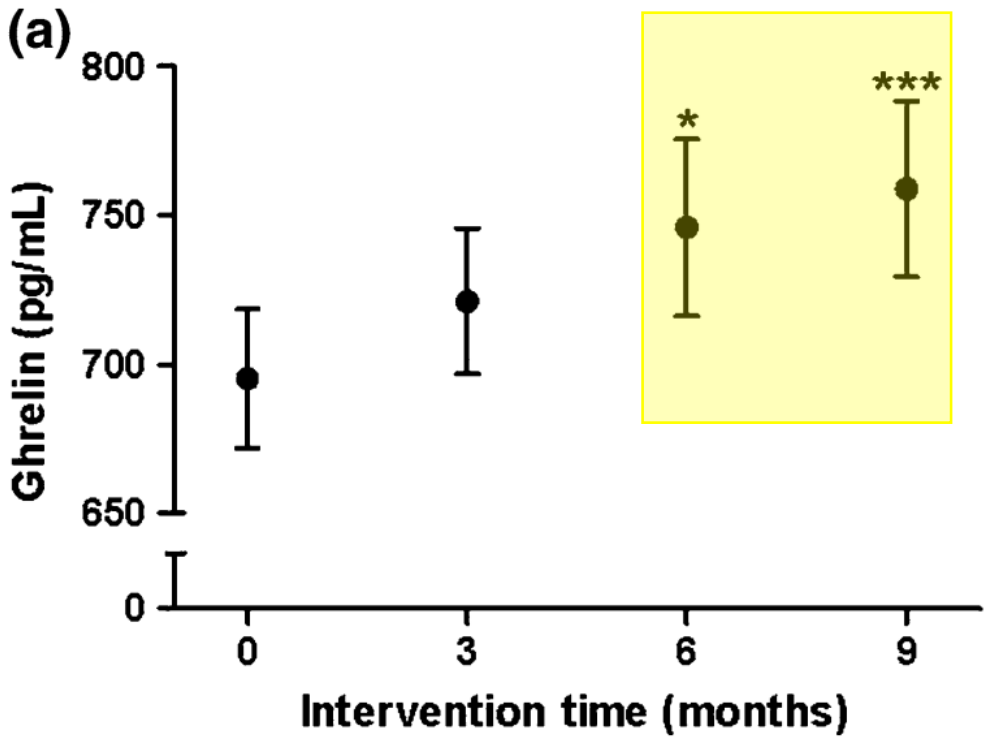


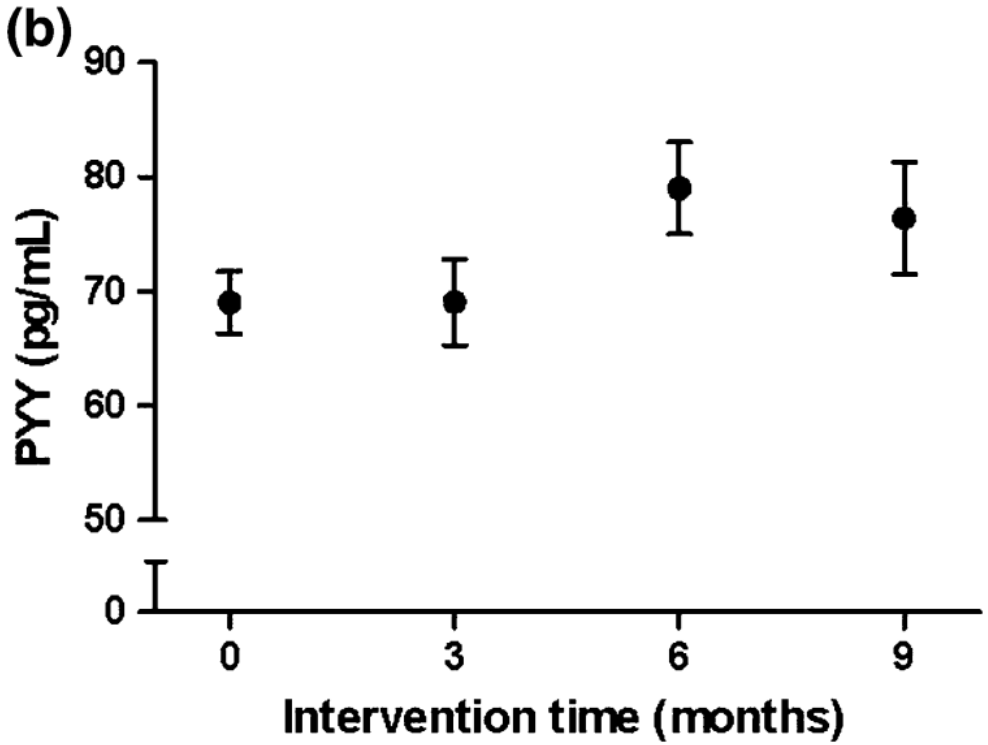
Figure 2 Effect size forest plot for absolute energy intake (mean ± 95% confidence intervals).

Figure 2 — Effects of exercise at ventilatory threshold on hunger feelings in obese teenage girls.



Prado, W. L., Lofrano-Prado, M. C., Tenório, T. R. S., Balagopal, P. B., Oyama, L. M., Botero, J. P., & Hill, J. O. (2014). *Effect of Aerobic Exercise on Hunger Feelings and Satiety Regulating Hormones in Obese Teenage Girls. Pediatric Exercise Science, 26(4), 463–469.* doi:10.1123/pes.2013-0200





Gueugnon, C., Mougin, F., Nguyen, N. U., Bouhaddi, M., Nicolet-Guénat, M., & Dumoulin, G. (2011). Ghrelin and PYY levels in adolescents with severe obesity: effects of weight loss induced by long-term exercise training and modified food habits. European Journal of Applied Physiology, 112(5), 1797–1805. doi:10.1007/s00421-011-2154-2

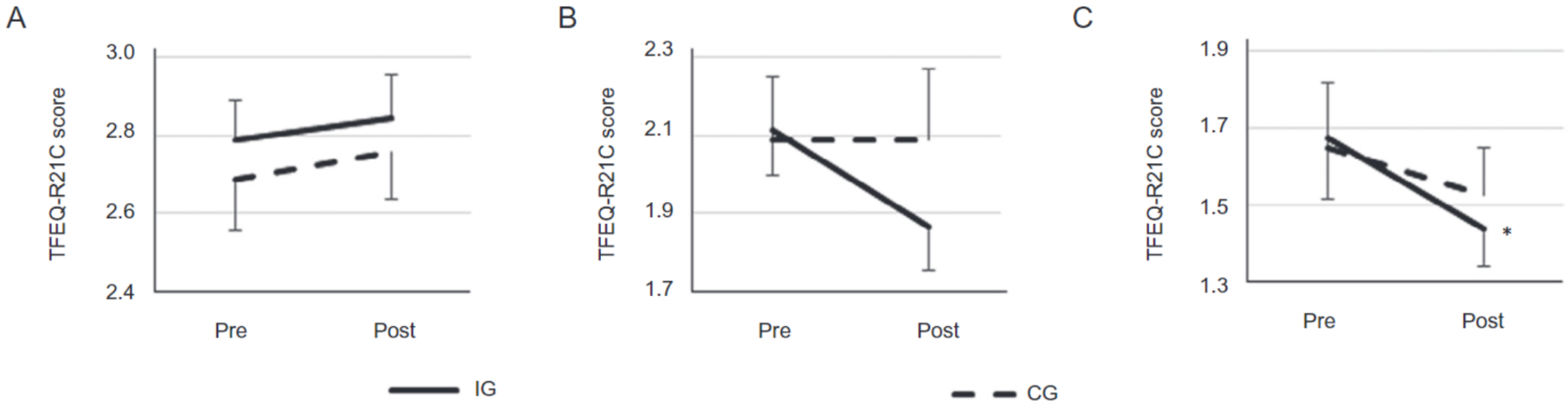


Fig. 1. Changes in Three-Factor Eating Questionnaire-R21 for children and adolescents (TFEQ-R21C) factors before (pre) and after (post) the 3-month physical activity intervention. Data split by groups of exercise (intervention group, IG) and non-exercise (control group, CG). (A) Cognitive Restraint; (B) Uncontrolled Eating; and (C) Emotional Eating. Data expressed as mean ± SE to improve its legibility. *$p < 0.05$, compared with the post value in IG.

Martín-García, M., Alegre, L. M., García-Cuartero, B., Bryant, E. J., Gutin, B., & Ara, I. (2017). *Effects of a 3-month vigorous physical activity intervention on eating behaviors and body composition in overweight and obese boys and girls. Journal of Sport and Health Science.* doi:10.1016/j.jshs.2017.09.012

Table 1
General physical characteristics and body composition variables before and after the vigorous physical activity intervention (mean ± SD).

Variable	Intervention group ($n = 28$) (mean Tanner = 2.6)			Control group ($n = 19$) (mean Tanner = 2.6)			p	
	Pre	Post	Δ (%)	Pre	Post	Δ (%)	Time main effect	Time × group interaction
Age (year)	11.5 ± 2.4	11.7 ± 2.4*	1.7	11.1 ± 2.6	11.3 ± 2.6*	1.8	**<0.001**	0.692
Body mass (kg)	67.1 ± 6.5	66.9 ± 16.0	−0.3	69.4 ± 19.6	70.6 ± 19.8	1.7	0.134	**0.047**
Height (cm)	153.4 ± 12.9	154.7 ± 12.5*	0.8	153.1 ± 15.9	155.0 ± 15.6*	1.2	**<0.001**	0.051
BMI (kg/m^2)	28.1 ± 3.6	27.6 ± 3.6*	−1.8	28.9 ± 3.1	28.7 ± 3.2	−0.7	**0.017**	0.239
%BF	43.4 ± 4.5	42.2 ± 5.0*	−2.8	44.6 ± 5.2	44.4 ± 5.3	−0.4	**0.010**	0.082
FM (kg)								
FM whole body	29.0 ± 8.5	28.1 ± 8.3	−3.1	31.1 ± 10.0	31.3 ± 9.8	0.6	0.228	0.071
FM trunk	13.4 ± 4.6	13.3 ± 4.8	−0.7	14.7 ± 4.9	14.8 ± 4.6	0.7	0.884	0.339
FM lower extremities	11.8 ± 3.3	11.4 ± 3.2	−3.4	12.5 ± 4.5	12.6 ± 4.6	0.8	0.352	0.052
FM upper extremities	2.9 ± 0.9	2.6 ± 0.7*	−10.3	3.0 ± 1.0	2.9 ± 0.9*	−3.3	**<0.001**	**0.015**
LM (kg)								
LM whole body	35.4 ± 8.8	36.1 ± 8.9*	2.0	36.0 ± 10.5	36.7 ± 10.8	1.9	**0.001**	0.864
LM trunk	16.1 ± 4.0	16.5 ± 4.2*	2.5	16.6 ± 5.0	16.9 ± 5.4	1.8	**0.003**	0.561
LM lower extremities	12.6 ± 3.5	12.9 ± 3.5*	2.4	12.7 ± 4.0	13.0 ± 4.0*	2.4	**<0.001**	0.810
LM upper extremities	3.6 ± 1.2	3.6 ± 1.1	0.0	3.9 ± 1.3	3.9 ± 1.3	0.0	0.457	0.490

* $p \leq 0.05$, compared with pre-intervention values.
Abbreviations: Δ = changes between pre- and post-intervention; %BF = percentage of body fat; BMI = body mass index; FM = fat mass; LM = lean mass.

Martín-García, M., Alegre, L. M., García-Cuartero, B., Bryant, E. J., Gutin, B., & Ara, I. (2017). *Effects of a 3-month vigorous physical activity intervention on eating behaviors and body composition in overweight and obese boys and girls. Journal of Sport and Health Science.* doi:10.1016/j.jshs.2017.09.012

Physiology & Behavior
Volume 199, 1 February 2019, Pages 56-65

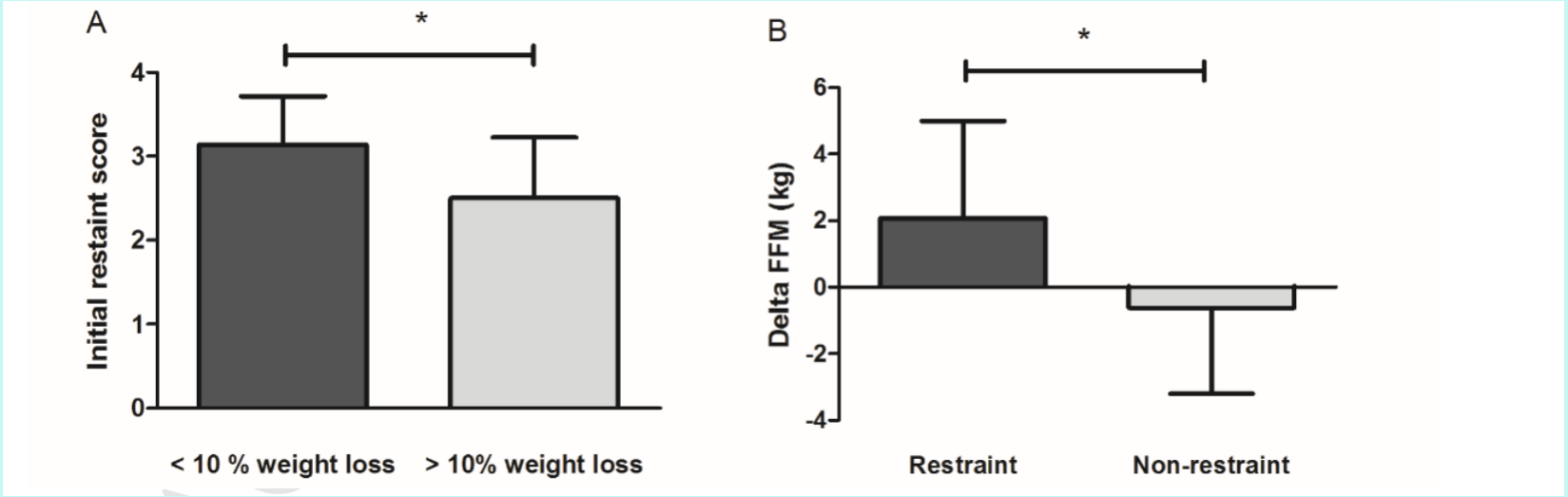
Structured, aerobic exercise reduces fat mass and is partially compensated through energy intake but not energy expenditure in women

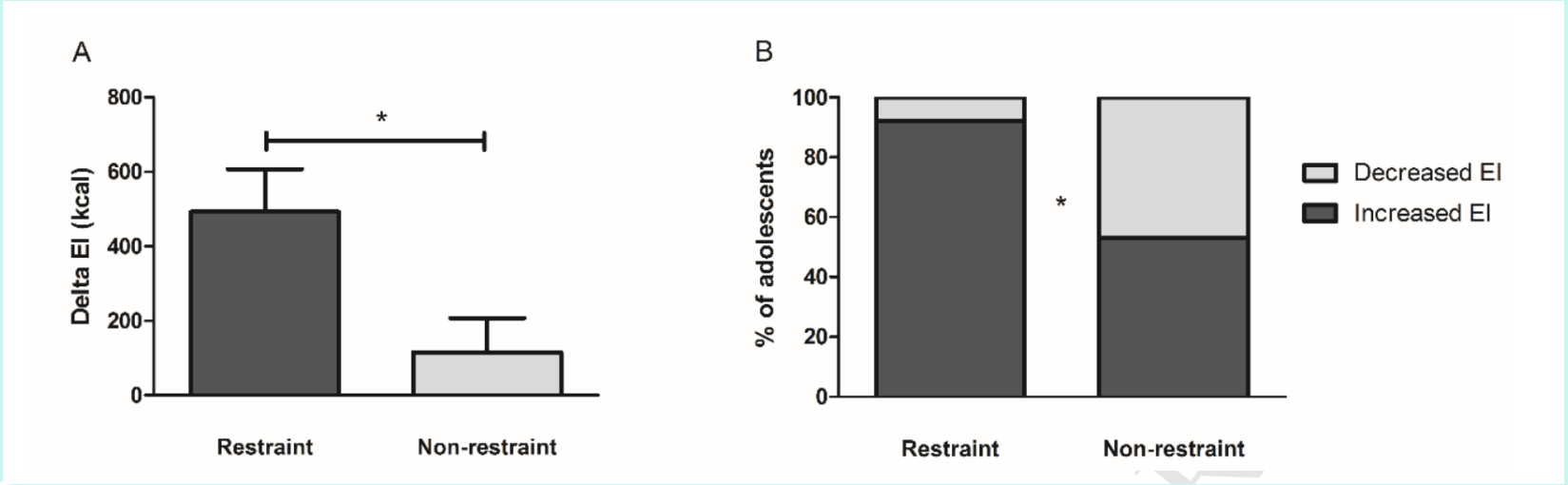
Anna Myers [a], Michelle Dalton [b], Catherine Gibbons [c], Graham Finlayson [c], John Blundell [c]

Cognitive Restriction
No time effect

External Eating
↓ In boys and girls

Emotional Eating
↓ In boys

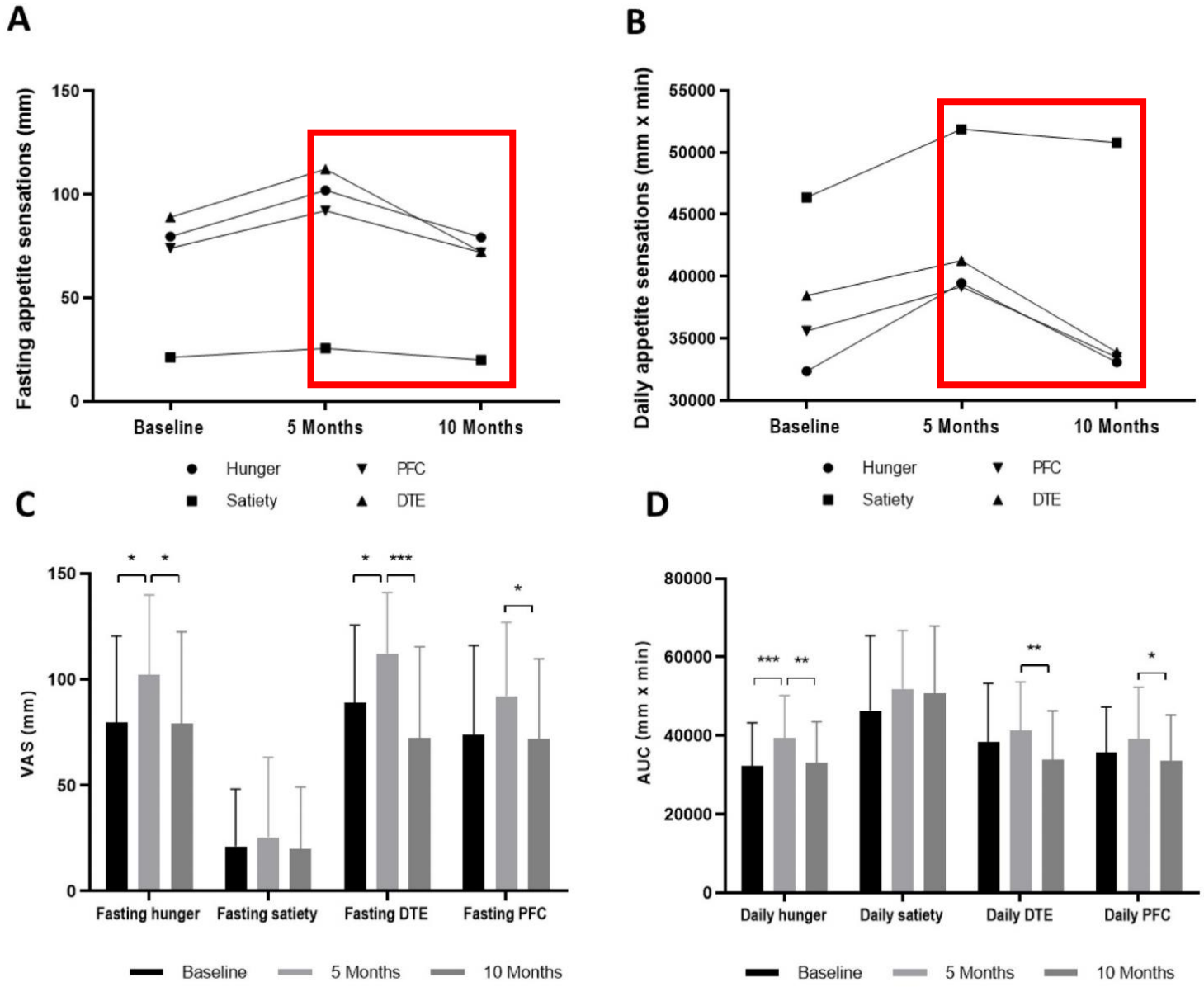




Miguet, M., Masurier, J., Chaput, J. P., Pereira, B., Lambert, C., Dâmaso, A. R., ... Thivel, D. (2019). *Cognitive restriction accentuates the increased energy intake response to a 10-month multidisciplinary weight loss program in adolescents with obesity. Appetite, 134, 125–134.* doi:10.1016/j.appet.2018.12.015

↑ libitum energy intake

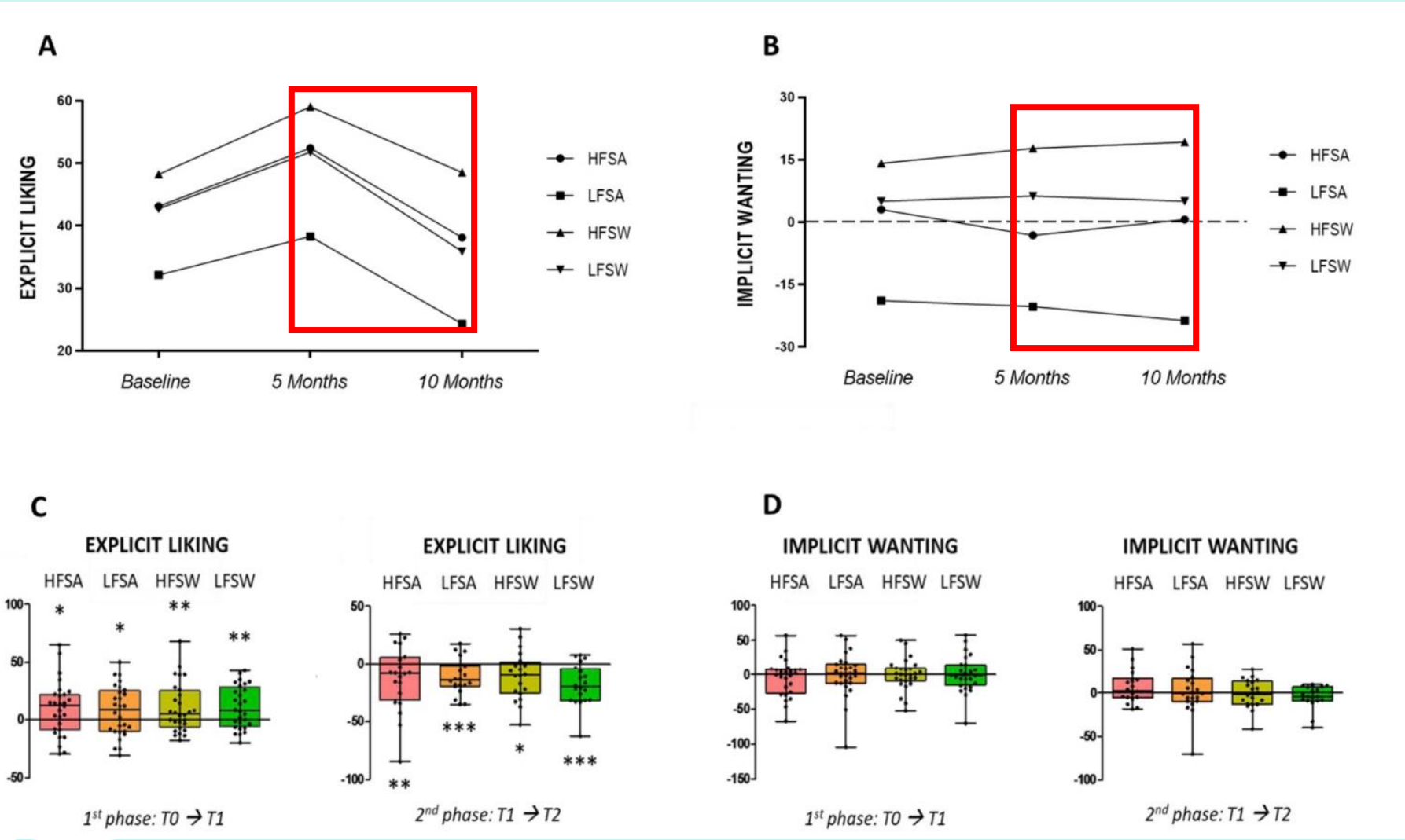
↓ Appetite Sensation



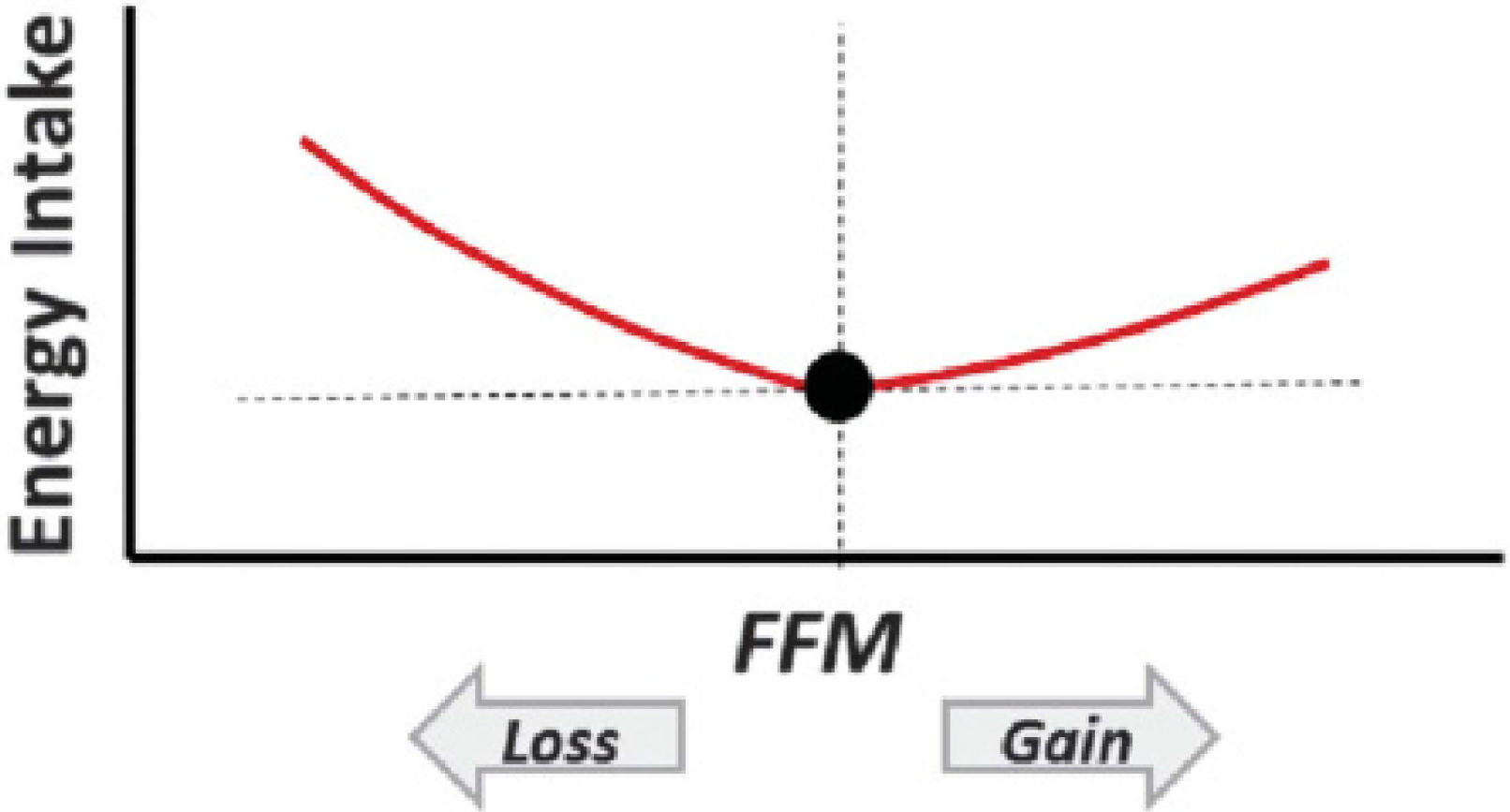
Miguet, M., Beaulieu, K., Fillon, A., Khammassi, M., Masurier, J., Lambert, C., ... Thivel, D. (2020). *Effect of a 10-month residential multidisciplinary weight loss intervention on food reward in adolescents with obesity. Physiology & Behavior, 112996.* doi:10.1016/j.physbeh.2020.112996

↑ libitum energy intake

↓ Explicit liking



Miguet, M., Beaulieu, K., Fillon, A., Khammassi, M., Masurier, J., Lambert, C., ... Thivel, D. (2020). *Effect of a 10-month residential multidisciplinary weight loss intervention on food reward in adolescents with obesity. Physiology & Behavior, 112996.* doi:10.1016/j.physbeh.2020.112996


Energy Intake
FFM
Loss
Gain

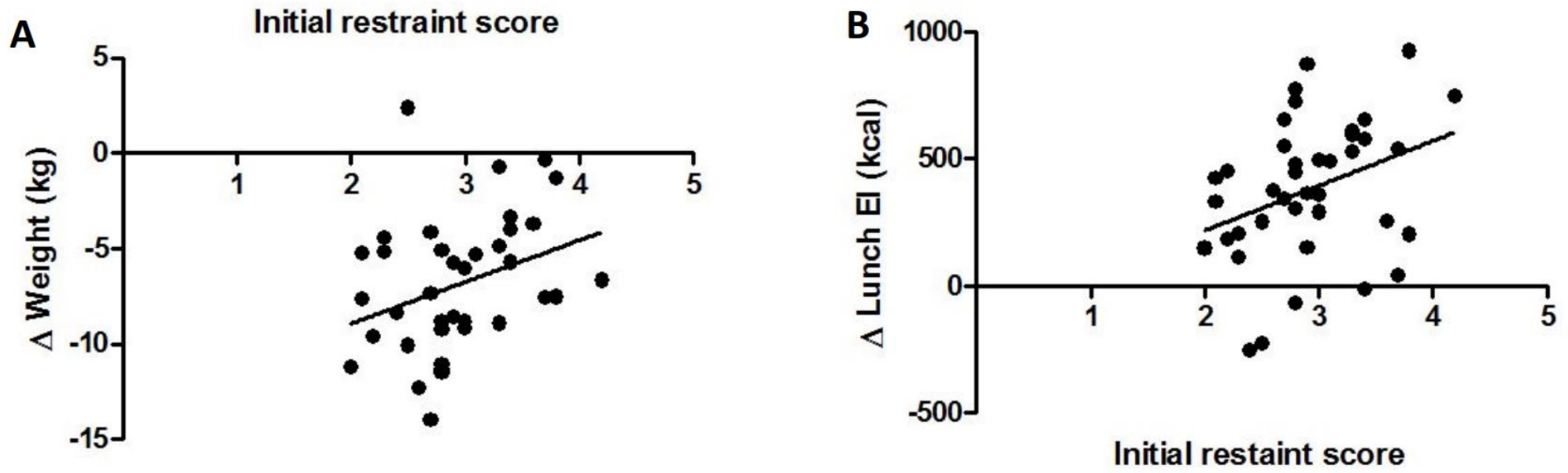
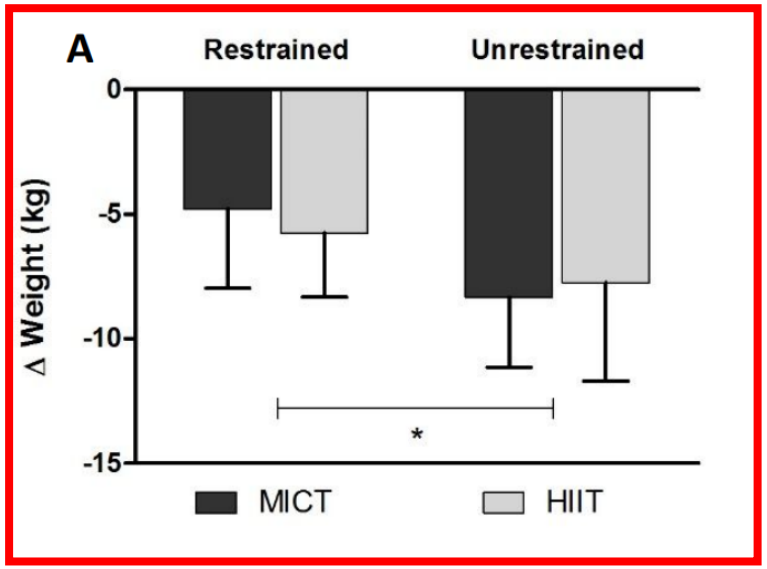
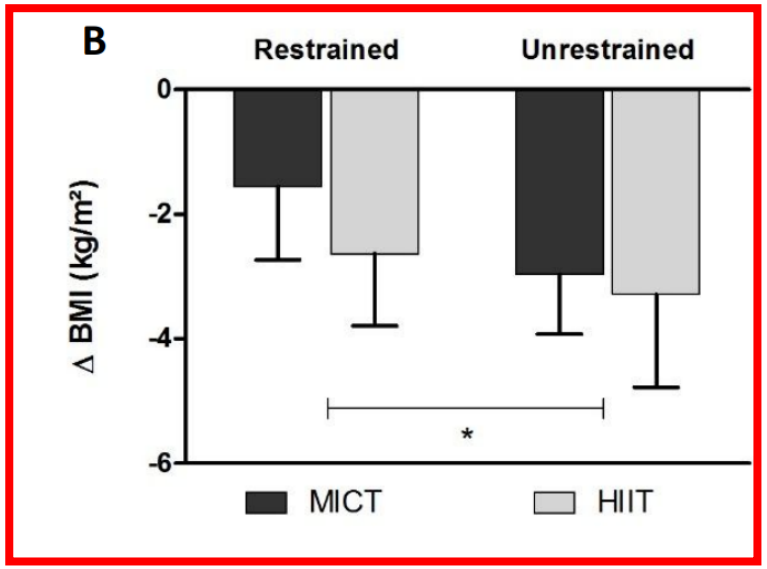


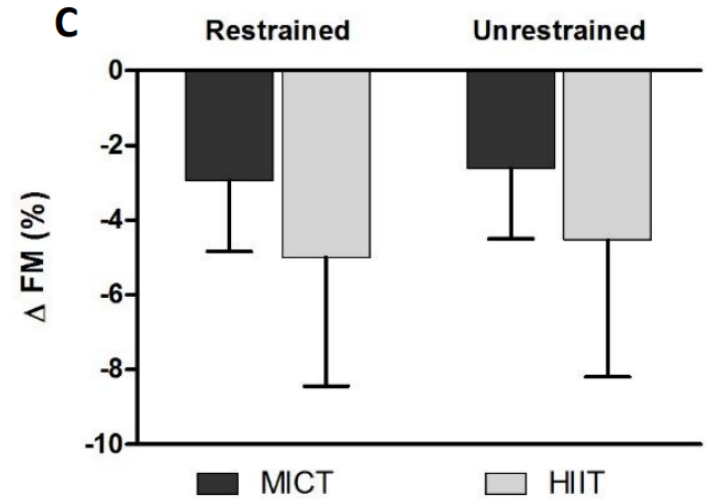
Figure 2. Associations between initial restraint score and variations in weight (A) and lunch *ad libitum* energy intake (B) from baseline to 16 weeks. **A: r=0.33, p=0.045; B: r=0.34, p=0.03; Δ: delta from baseline to 16 weeks**

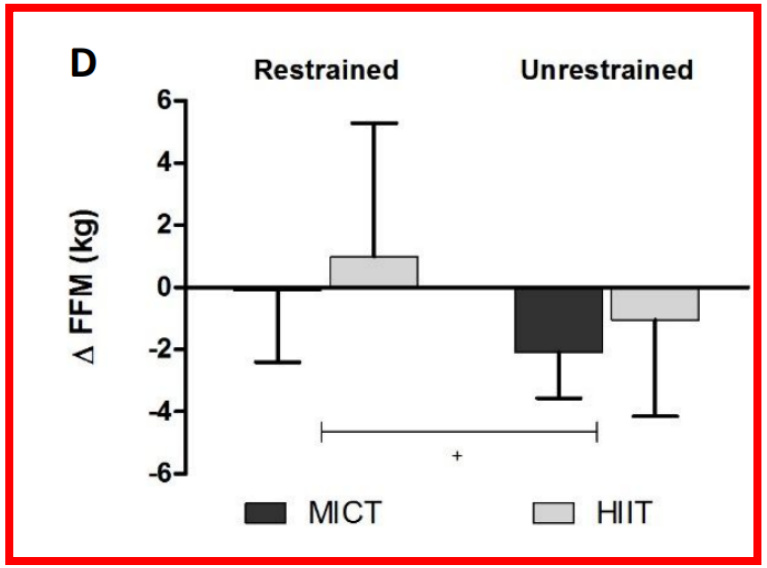
Miguet, M., Fearnbach, S. N., Metz, L., Khammassi, M., Julian, V., Cardenoux, C., ... Thivel, D. (2019). *Effect of HIIT versus MICT on body composition and energy intake in dietary restrained and unrestrained adolescents with obesity. Applied Physiology, Nutrition, and Metabolism.*

Figure 1. Body composition change from baseline to 16 weeks among MICT and HIIT groups, separated by baseline eating behavior profile. A: Weight; B: BMI; C: FM; D: FFM; *: p

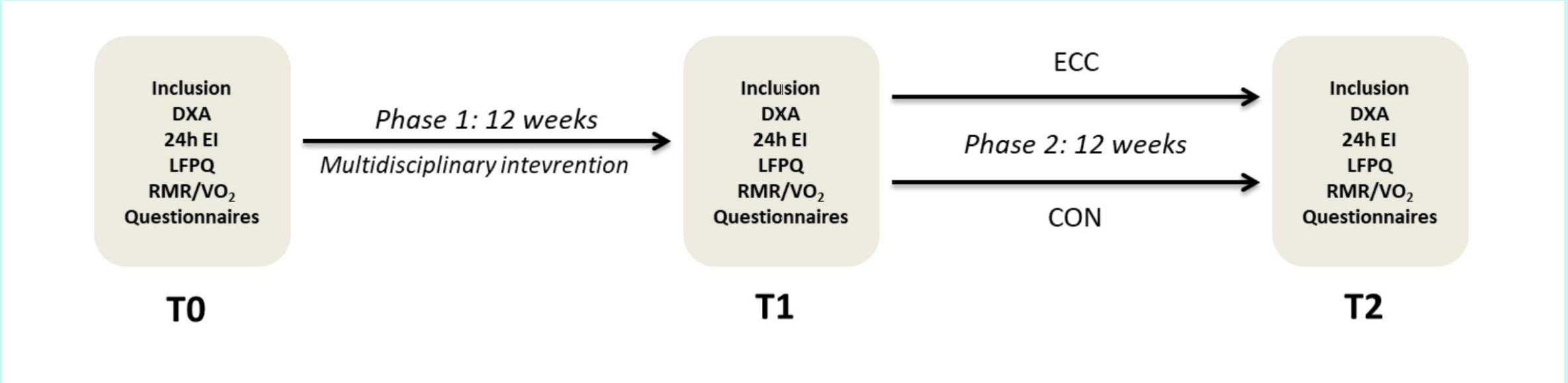








Miguet, M., Fearnbach, S. N., Metz, L., Khammassi, M., Julian, V., Cardenoux, C., ... Thivel, D. (2019). *Effect of HIIT versus MICT on body composition and energy intake in dietary restrained and unrestrained adolescents with obesity. Applied Physiology, Nutrition, and Metabolism.*



Thivel, D., Julian, V., Miguet, M., Pereira, B., Beaulieu, K., Finlayson, G., ... Duclos, M. (2019). Introducing eccentric cycling during a multidisciplinary weight loss intervention might prevent adolescents with obesity from increasing their food intake: the TEXTOO study. Physiology & Behavior, 112744.

Fillon, A., Mathieu, M. E., Masurier, J., Roche, J., Miguet, M., Khammassi, M., ... Thivel, D. (2019). Effect of exercise-meal timing on energy intake, appetite and food reward in adolescents with obesity: The TIMEX study. Appetite, 104506. doi:10.1016/j.appet.2019.104506

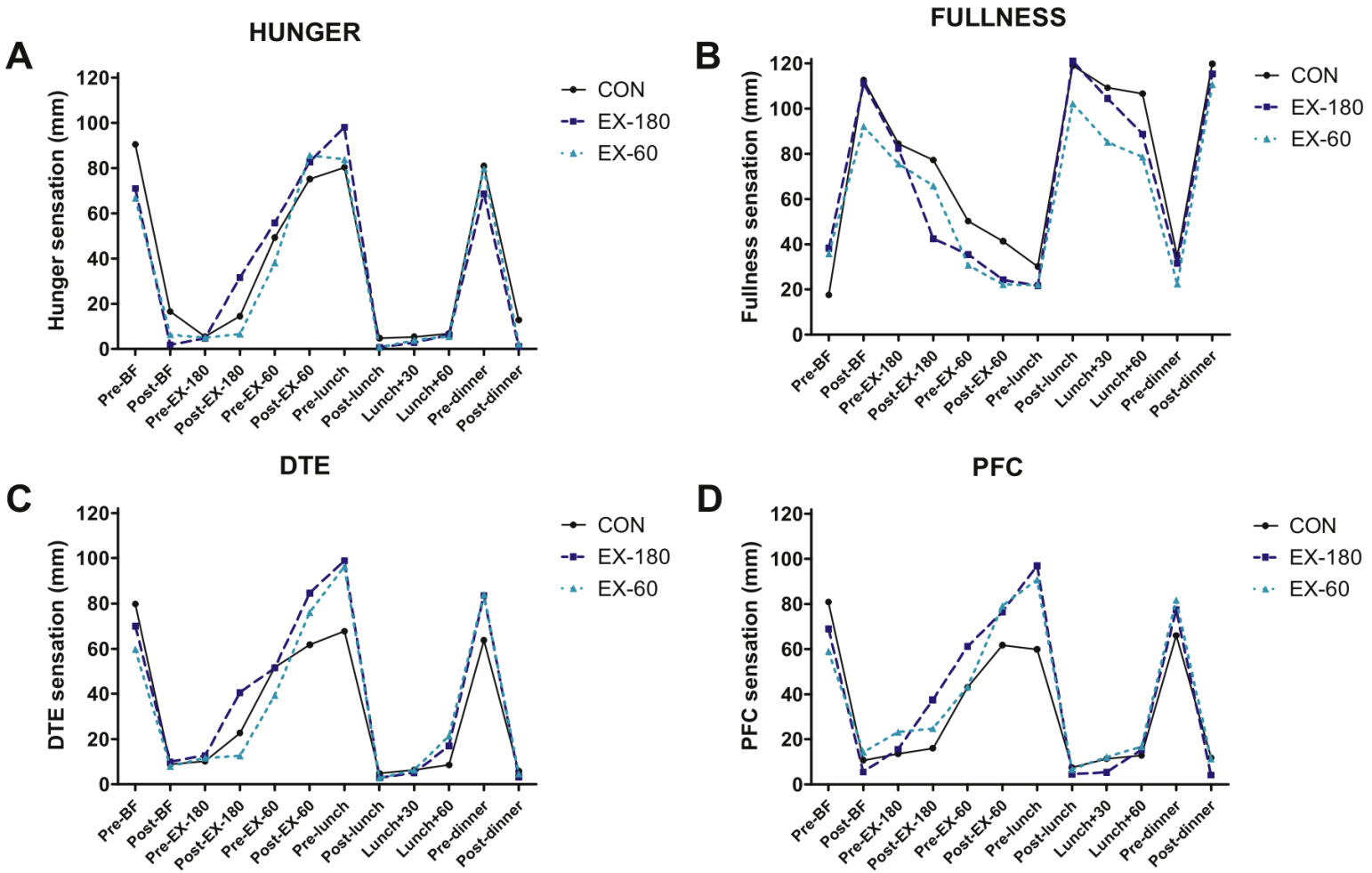
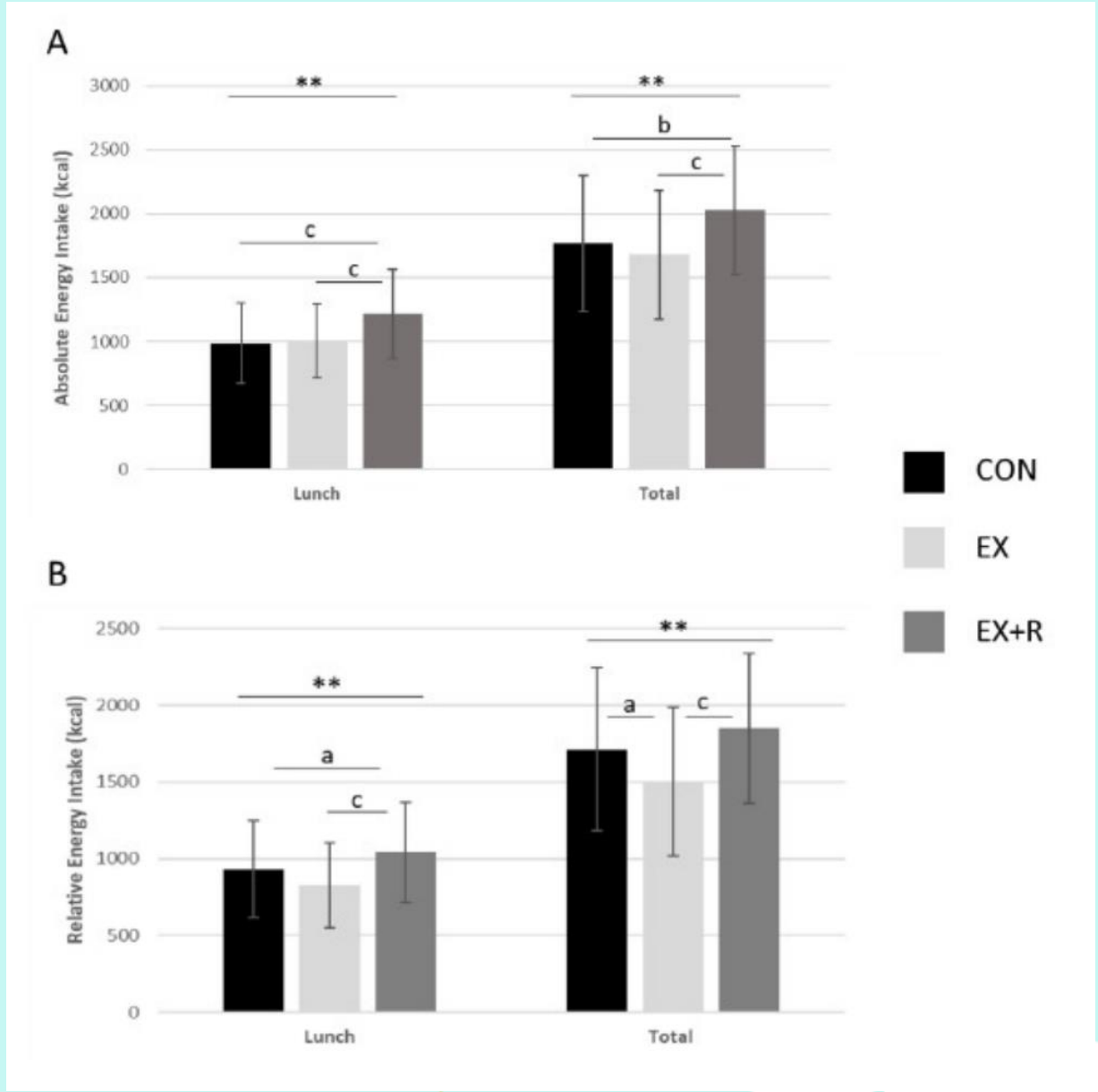


Fig. 1. Daily appetite sensations.

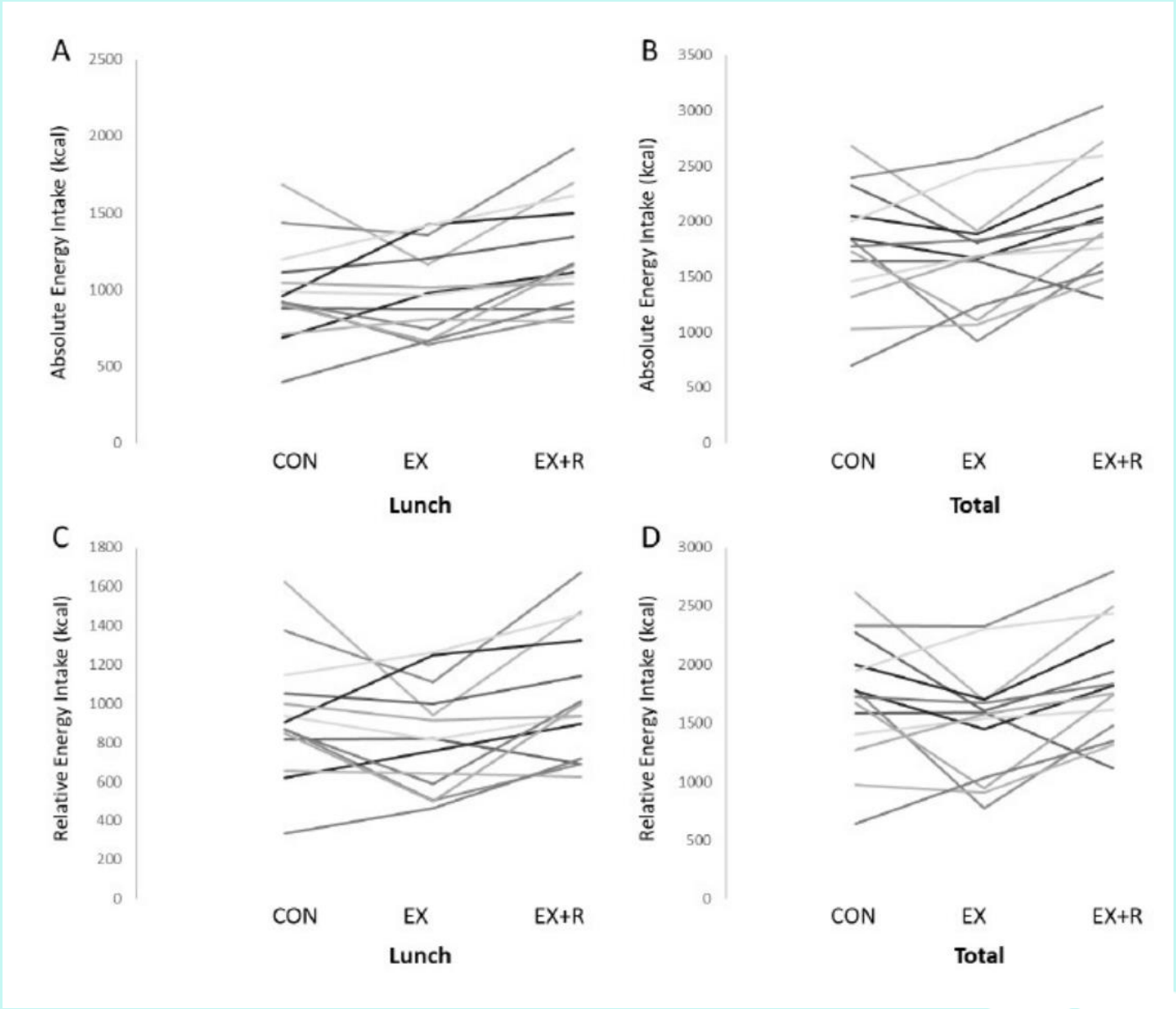
Fig. 1. Daily Hunger (A); Fullness (B); DTE (C) and PFC (D) during the CON (black line), EX-180 (blue line) and EX-30 (light-blue line). DTE; Desire to Eat; PFC: Prospective Food Consumption; BF: Breakfast; CON: rest condition; EX-60: Exercise 60 min before test meal; EX-180: Exercise 180 min before test meal; AUC EX-180 and AUC EX-60 > AUC CON for DTE ($p < 0.01$).

Figure 1. Absolute (A) and relative (B) energy intake in the control (CON), exercise with energy deficit (EX) and exercise with energy replacement (EX+R) conditions. Values are mean (SD) for n = 14. Values for EX-R include the energy content of the post-exercise snack. (**p



Thivel, D., Roche, J., Miguet, M., Fillon, A., Khammassi, M., Beaulieu, K., ... Boirie, Y. (2019). *Post- moderate intensity exercise energy replacement does not reduce subsequent appetite and energy intake in adolescents with obesity. British Journal of Nutrition, 1–19.*

Figure 2. Individual variation of absolute energy intake at lunch (A) and total (B) and of relative energy intake at lunch (C) and total (D) in the control (CON), exercise with energy deficit (EX) and exercise with energy replacement (EX+R) conditions. Values are mean (SD) for n = 14. Values for EX-R include the energy content of the post-exercise snack.



Thivel, D., Roche, J., Miguet, M., Fillon, A., Khammassi, M., Beaulieu, K., ... Boirie, Y. (2019). *Post- moderate intensity exercise energy replacement does not reduce subsequent appetite and energy intake in adolescents with obesity. British Journal of Nutrition, 1–19.*

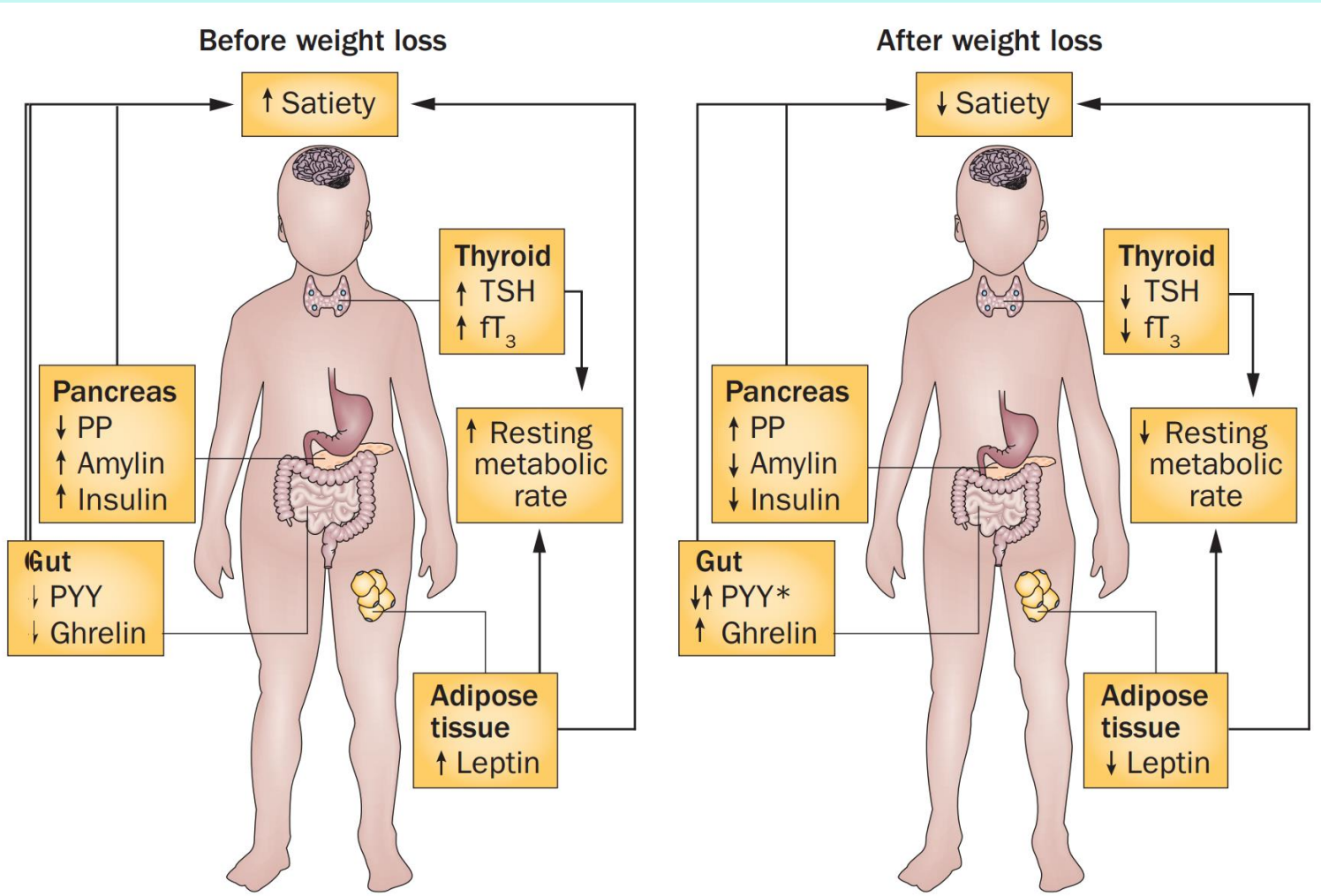
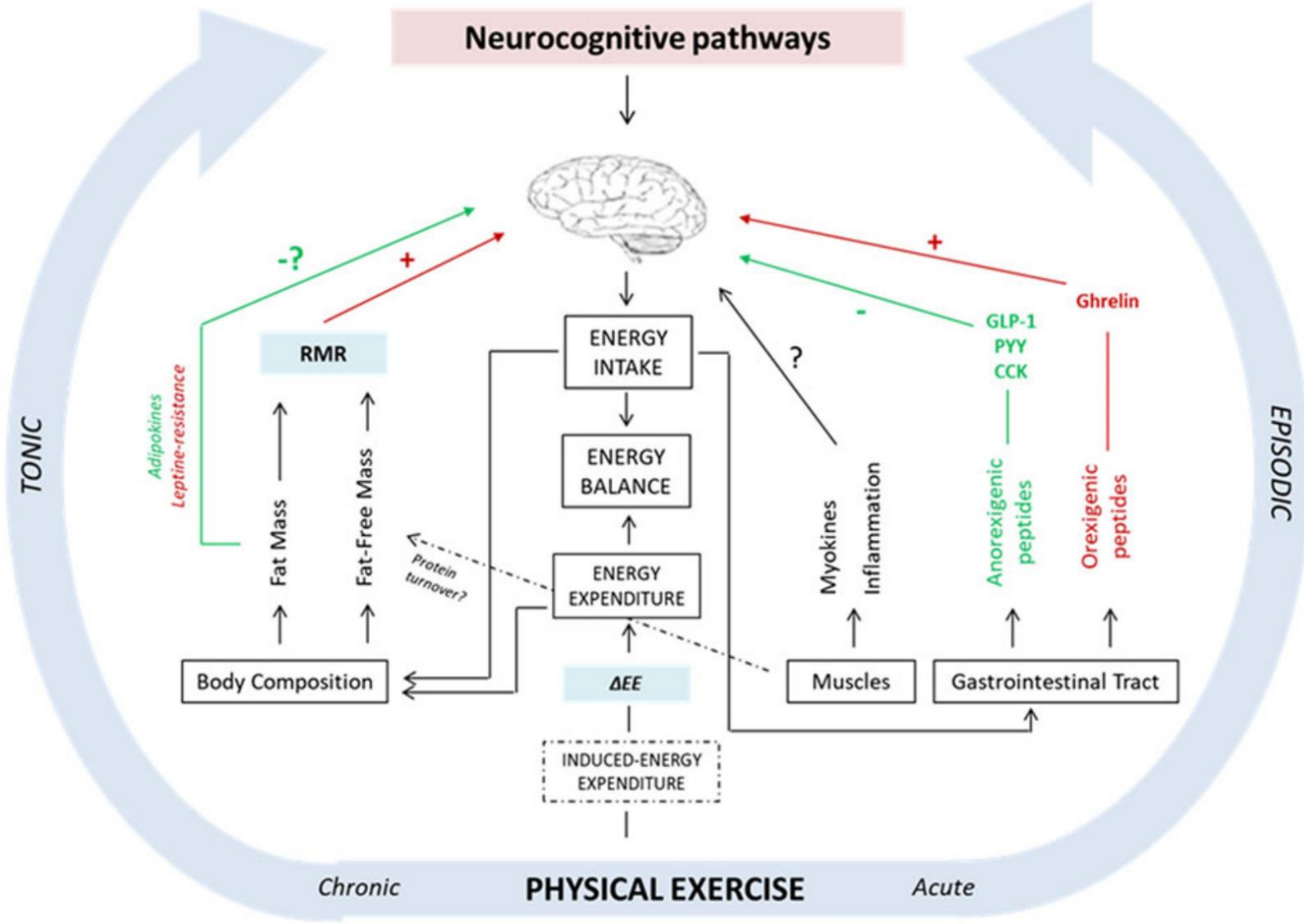
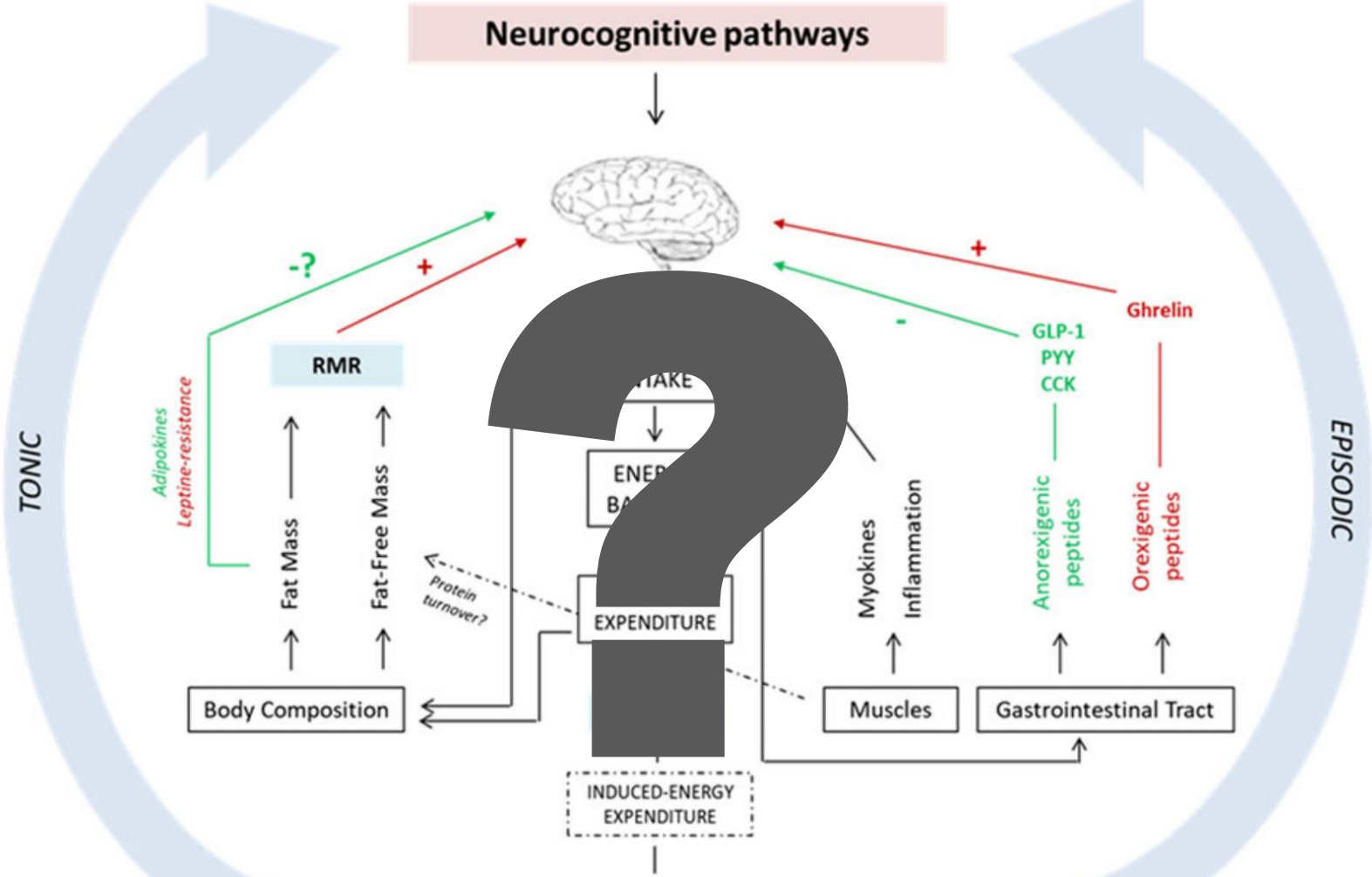


Figure 1 | Hormonal changes in children with obesity before and after weight loss. *Studies are not consistent with regard to the effect on PYY after weight loss. Except for PYY and PP, all changes in hormones in weight loss prevent weight maintenance. Abbreviations: fT_3, free T_3; PP, pancreatic polypeptide; PYY, peptide YY.[81–95]

Reinehr, T. (2013). *Lifestyle intervention in childhood obesity: changes and challenges. Nature Reviews Endocrinology, 9(10), 607–614.*


Neurocognitive pathways
-?
+
+
-
Ghrelin
GLP-1
PYY
CCK
RMR
ENERGY INTAKE
?
ENERGY BALANCE
ENERGY EXPENDITURE
Adipokines
Leptine-resistance
Fat Mass
Fat-Free Mass
Protein turnover?
Myokines
Inflammation
Anorexigenic peptides
Orexigenic peptides
TONIC
EPISODIC
Body Composition
ΔEE
Muscles
Gastrointestinal Tract
INDUCED-ENERGY EXPENDITURE
Chronic
PHYSICAL EXERCISE
Acute


Neurocognitive pathways
TONIC
EPISODIC
-?
+
+
-
Ghrelin
GLP-1
PYY
CCK
RMR
Adipokines
Leptine-resistance
Fat Mass
Fat-Free Mass
Protein turnover?
EXPENDITURE
Myokines
Inflammation
Anorexigenic peptides
Orexigenic peptides
Body Composition
Muscles
Gastrointestinal Tract
INDUCED-ENERGY EXPENDITURE
Chronic
PHYSICAL EXERCISE
Acute

Thank you!