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ADAPTATIONS ÉNERGÉTIQUES AUX VARIATIONS DE POIDS ET AU STATUT HORMONAL OVARIEN CHEZ LES ATHLÈTES

- ANNEXES -

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ANNEXE 1

Les régimes alimentaires présentent-ils un risque de prise de poids chez les individus normo-pondérés ?
Revue systématique et méta-analyse

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Is dieting a risk for higher weight gain in normal-weight individual? A systematic review and meta-analysis

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Abstract

While there is an increasing prevalence of dieting in the overall population, weight loss (WL) practices could be a risk factor for weight gain (WG) in normal-weight (NW) individuals. The aim of the present work was to systematically review all the studies implicating diet restriction and body weight (BW) evolution in NW people. The literature search was registered in PROSPERO (CRD42021281442) and was performed in three databases from April 2021 to June 2022 for articles involving healthy NW adults. From a total of 1487 records initially identified, eighteen were selected in the systematic review. Of the eight dieting interventional studies, only one found a higher BW after weight recovery, but 75% of them highlighted metabolic adaptations in response to WL favouring weight regain and persisting during/after BW recovery. Eight of the ten observational studies showed a relationship between dieting and major later WG, while the meta-analysis of observational studies results indicated that 'dieters' have a higher BW than 'non-dieters'. However, considering the high methodological heterogeneity and the publication bias of the studies, this result should be taken with caution. Moreover, the term 'diet' was poorly described, and we observed a large heterogeneity of the methods used to assess dieting status. Present results suggest that dieting could be a major risk factor for WG in the long term in NW individuals. There is, however, a real need for prospective randomised controlled studies, specifically assessing the relationship between WL induced by diet and subsequent weight in this population.

Key words: Food restriction: Lean: Weight loss: Weight gain: Obesity

Obesity and its cardiometabolic consequences have become a worldwide preoccupation, given the rapid increase in its prevalence in recent years. The literature on weight loss (WL) management is well documented, dieting (*i.e.* 'restrict oneself to small amounts or special kinds of food in order to lose weight' – *Oxford Dictionary*) being one of the most popular strategies, leading to significant beneficial effects on patients' body weight (BW), body composition, and cardiometabolic health^(1–3).

Interestingly, while there is a high prevalence of dieting among individuals with elevated BMI, WL attempts also concern a significant and increasing proportion of normal-weight (NW) individuals^(4–6). For example, among French dieters, for instance, 33% of men and 57% of women are NW subjects⁽⁶⁾. Indeed, the media and social pressure related to leanness, and the widespread notion of an ideal body shape may alter body perception, particularly among young adults^(7–10). As illustrated in a cohort of

Abbreviations: BW, body weight; FFM, fat-free mass; FM, fat mass; NW, normal weight; REE, resting energy expenditure; WG, weight gain; WL, weight loss.

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European university students, 60% of women with an average BMI of 22.5 kg/m² considered themselves as 'a little too fat'⁽⁹⁾. Body image distortion is often associated with the desire to lose weight⁽¹¹⁾, and leads individuals to engage in dieting independently of any need for weight management in terms of cardiometabolic health. In contrast, while dieting is associated with health improvements in people with overweight or obesity, it conversely could constitute a potential risk factor for increased adiposity and cardiometabolic disease, particularly in NW people. Indeed, in 2015, Dulloo and collaborators suggested that NW individuals might have a higher risk to experience post-WL 'fat overshooting' than people with obesity⁽¹²⁾. This phenomenon is well illustrated in the Minnesota Starvation Experiment, in which thirty-two healthy NW males sustained a 24-week semi-starvation, and lost an average of 25% of their initial BW^(13–15). During weight recovery, adaptive thermogenesis and hyperphagia induced a fast rebound of fat mass (FM) (*i.e.* preferential catch-up fat), resulting in FM being fully recovered earlier than fat-free mass (FFM). However, the hyperphagia was found to persist until FFM returned to its initial value, leading hence to higher FM values than those prior to semi-starvation (*i.e.* fat overshooting)^(14,16). Importantly, the leaner the participant at baseline, the higher proportion of FFM lost during WL and the greater the risk of fat overshooting during recovery^(12,16).

Interestingly, a recent narrative review suggested some beneficial effects (*e.g.* increased insulin sensitivity) of interventional dietary-induced WL in NW subjects, still pointing the lack of evidence among healthy lean individuals, since most of the available evidence concerns people suffering from metabolic disorders (such as hypertension or insulin resistance)⁽¹⁷⁾. In addition, some observational studies showed benefits of energetic restriction in healthy NW individuals such as an improvement of lipid and glycemic profiles⁽¹⁸⁾, or an important decrease in global mortality^(19,20). However, it concerned specific populations (*e.g.* Okinawans) who sustain a low-energy intake during all their lifespan^(18–20), and it was well established that the 'obesogenic environment' of our actual societies, including high food availability, makes it difficult to maintain a low-energy diet on the long term^(21–23). Thus, due to the high probability of regaining the weight lost after a diet, individuals engaging in dieting may experience repeated WL and regains during their lifespan, a phenomenon called 'weight cycling'. Weight cycling is associated with an increased risk of cardiometabolic impairments such as hyperinsulinemia, insulin resistance, hypertension, and hypertriglycerolaemia, specifically in NW individuals⁽⁴⁾. In addition, associated with the fat overshooting theory described above, weight fluctuations are also related to major long-term weight gain (WG)⁽⁴⁾. However, the long-term effects of dieting on BW and body composition changes in NW healthy people remain unclear. In their prospective observational study, Lowe *et al.* showed that NW current dieter women gained almost three times more BW than non-dieters after an 8-month period (5 kg *v.* 1.6 kg, respectively)⁽²⁴⁾. In contrast, in a study performed in a large cohort (*n* 4159, aged 18–29 years), women who declared dieting at baseline gained as much BW as non-dieters after 15 years, while in young men, dieters tended to gain more BW than non-dieters⁽²⁵⁾. However, the majority of longitudinal studies that concern weight evolution in the overall population have

relied on self-reported data^(25–27) and have not considered body composition variations (*i.e.* FM and FFM).

While there is an increasing concern for weight control in healthy NW individuals leading them to regularly engage in dietary WL strategies, there is a clear need to question the potential effects of dieting on their BW and body composition. Therefore, the aim of the present work was (i) to conduct a systematic overview of the available studies involving dieting and WL, BW, and body composition in NW healthy people, and (ii) to determine the effect of dieting on subsequent and/or long-term BW in NW healthy individuals using a meta-analytic approach. In doing so, the results may help to better decipher the risks and/or benefits to healthy NW individuals engaging in dieting and to promote adapted public health messaging related to diet, based on robust scientific evidence.

Methods

This systematic review and meta-analysis followed the recommendations from the PRISMA statement⁽²⁸⁾, and the protocol was prospectively registered in the International Prospective Register of Systematic Reviews database (registration number: CRD42021281442).

Literature search strategy and article selection

The following electronic bibliographic databases were searched from April 2021, and the last run was performed in June 2022: PubMed-Medline, Embase, and Google Scholar. The search terms were a combination of medical subject headings (MeSH terms) and text words (title and abstract) which were adapted for use in each database. The main keywords selected were 'weight gain', 'weight change', 'weight loss', 'body weight', 'body composition', 'normal-weight', 'healthy', 'non-obese', 'diet/ing/ietary', and 'caloric restriction'. Limits were set to include all papers in healthy human adults published after 1945. The search was followed by a careful selection of eligible studies according to the criteria outlined below. References from narrative or systematic reviews and eligible publications were also screened to find additional records.

Inclusion and exclusion criteria

The inclusion criteria were as follows: (1) healthy (without pathology or co-morbidity) participants with initial BMI between 18.5 and 24.9 kg/m² (for the group mean); (2) adult women and men (data available from 18 to 55 years); (3) subjects who dieted in the past or dieted (*i.e.* restrict food to lose weight) during the study; (4) any study that mentioned weight changes (or the terms 'weight maintenance' or 'weight (re)gain') related to diet and WL, which included (i) dietary interventional studies with a follow-up after WL, (ii) longitudinal observational studies (over a few months to several years) with weight changes in dieters, and (iii) cross-sectional observational studies that compared BW and/or body composition between dieters and non-dieters; and (5) publications in English or French language. Studies involving animal models, athletes or trained individuals were not included nor were interventional protocols involving an imposed overfeeding (*i.e.* where subjects must ingest daily food

intake higher than their daily requirement) before and/or after WL.

Data extraction and synthesis

Search results were exported to a spreadsheet, and duplicates were removed. The first selection was performed based on titles only and then based on abstracts. Finally, remaining full texts were screened to assess eligibility according to the inclusion and exclusion criteria above. The selection process was performed independently by two reviewers, and any discrepancies were collectively discussed amongst these reviewers until a consensus was reached. The third reviewer was consulted when necessary. The flow diagram presented in Fig. 1 illustrates this selection process. Then, the qualitative data were extracted using a spreadsheet containing the following items chosen collectively by the authors: (1) reference; (2) population characteristics ('*n*' sample size, age, BMI, unique sample or specific sample analysed in others studies); (3) design of the study (randomised and/or controlled or not, longitudinal or cross-sectional, interventional or observational); (4) total duration of the study, number of measurement point and duration between each measurement point for longitudinal studies; (5) details of the intervention protocol for the interventional studies; (6) type of measurements or parameters assessed with details on the methods used; (7) details on subjects' food intake and/or diet; (8) main results for BW, weight changes and/or body composition; and (9) additional results linked to dietary or weight changes. When results were available for several groups, only those of control groups (called 'non-dieters') and the groups that matched the inclusion criteria were extracted. In addition, when BW and/or body composition data were not detailed in the paper, authors were contacted by email to obtain raw data and/or more information. When the extracted results were expressed as mean \pm SEM, SEM was converted into SD. The methods and main results of the selected interventional studies are displayed in Table 1. Table 2 details the methodological characteristics of the selected observational studies, while Table 3 presents its detailed main results.

Quality assessment

The quality assessment of the included studies was performed independently by two reviewers using the 'Quality Assessment Tool for Quantitative Studies' developed by the Effective Public Health Practice Project⁽²⁹⁾. Six criteria were assessed: selection bias, study design, confounders, blinding, data collection method, and withdrawals dropouts. Each criterion was qualified as 'strong', 'moderate', or 'weak'. The overall methodological quality was then rated as strong if there were no weak rating criteria, moderate if there was one weak rating, and weak if there were two or more weak ratings⁽³⁰⁾. Any discrepancies were collectively discussed among the two reviewers until a consensus was reached, and the third reviewer was consulted when necessary. The quality assessment described above was presented individually for each study and collectively represented using a summary bar plot (in %) for each criterion and the overall quality.

Meta-analysis procedure

Given that interventional studies presented a high heterogeneity in terms of WL protocol, a meta-analysis was performed from the quantitative data for the observational studies only. Publications were selected with more restrictive criteria, as follows: (i) comparison between groups considered like 'dieters' and 'non-dieters'; (ii) data on BW in kg in dieter and non-dieter groups; (iii) data in women-only considering the little number of available data in NW men; and (iv) data were estimated from graphs, as accurately as possible, if numerical values were not available in tables or text.

Statistical analysis

Statistical analyses were performed with Stata software (version 15, StataCorp). The meta-analysis considered between and within study variability. To address the non-independence of data due to the study effect, random effects model was preferred to the usual statistical tests to assess the standardised mean difference and their 95 % CI. More precisely, Hedge's *g* standardised mean difference was estimated to assess the BW difference between dieters and non-dieters. Means and standard deviation were compiled when available or were estimated when median and interquartile range were reported. When SD was not available, an estimation according to available SD, for other studies, was calculated. Hedge's *g* is considered to be a conservative estimate, which is useful for studies with small sample sizes, and the results may be interpreted as reflecting a small ($g = 0.2-0.5$), medium ($g = 0.5-0.8$) or large effect ($g > 0.8$). Heterogeneity in the study results was assessed by forest plots and the I^2 statistic which is the most common metric for measuring the magnitude of between-study heterogeneity. I^2 values range between 0 and 100 % and are typically considered low for < 25 %, moderate for 25–50 %, and high for > 50 %⁽³¹⁾. Publication bias was assessed by funnel plot, CI and with the Egger's regression test as a formal statistical test. Two-sided type I error was fixed at 5 %.

Results

Selection of the studies

The search yielded a total of 1320 publications identified from database searching and 167 records identified from additional sources, making a total of 1344 scientific articles after the removal of duplicates. Based on title and abstract screening, 1269 publications were excluded. A total of seventy-five records were fully read to assess the eligibility according to the inclusion and exclusion criteria. At this step of the selection process, fifty-seven articles were removed, as detailed in Fig. 1. Finally, a total of eighteen scientific papers remained in the qualitative analysis of the systematic review, published from 1990 to 2019.

Quality assessment

The quality of selection bias minimisation, study design, and blinding of participants and personnel was judged to be moderate for the majority of the studies. The quality of confounder



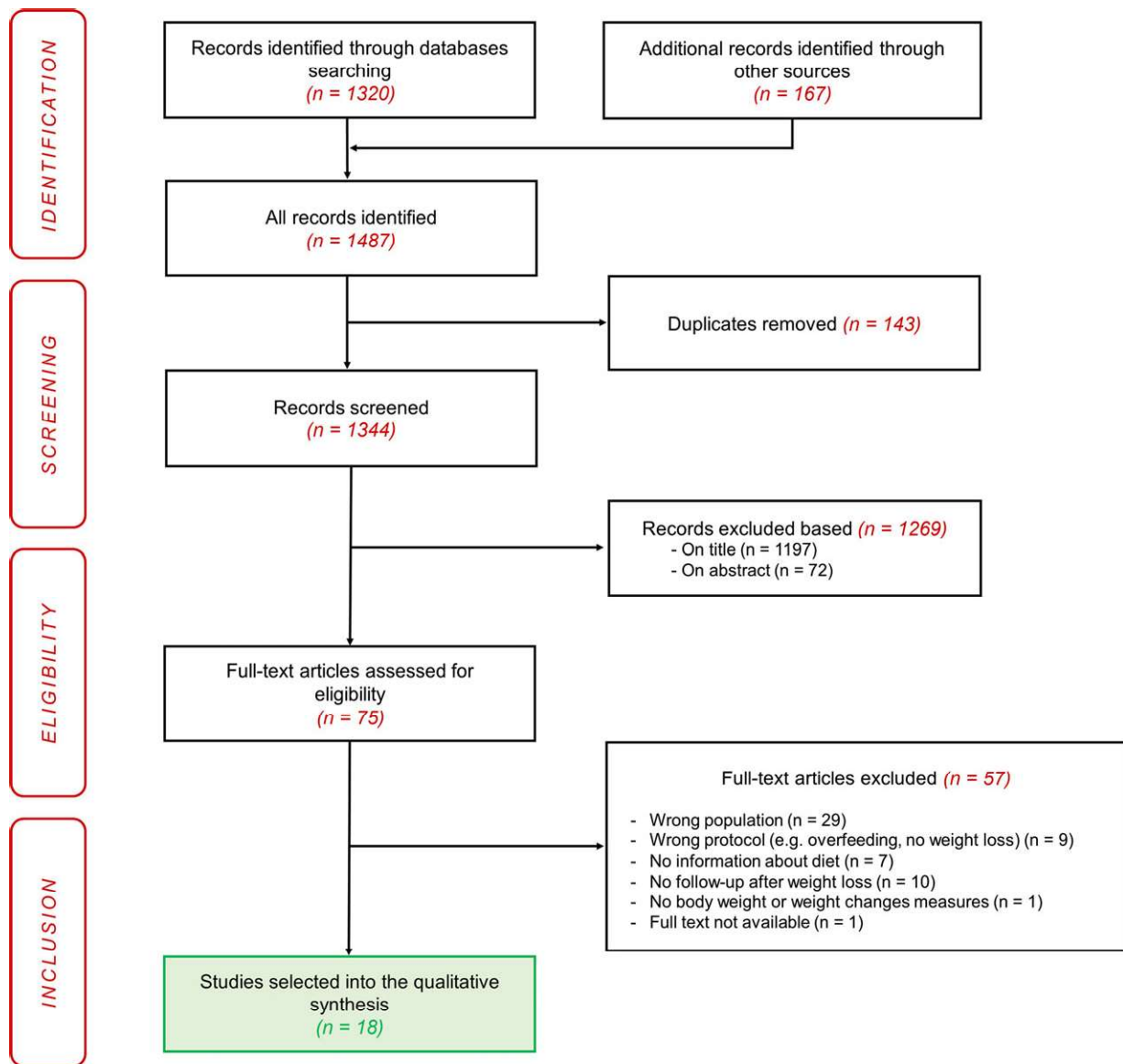


Fig. 1. Flow diagram of the identification, screening, eligibility, and inclusion of the studies in the systematic review.

reduction was considered as strong for 61 % ($n = 11$) and weak for 39 % ($n = 7$) of the studies. Data collection methods were judged strong for 56 % ($n = 10$) of the articles, while withdrawals and dropout were considered as strong for 33 % ($n = 6$). Finally, the global quality assessment was defined as strong for six studies^(13–15,24,25,32), moderate for nine studies^(27,33–40), and weak for three studies^(26,41,42). Individual quality assessment of the selected publications is detailed in Fig. 2.

Designs of the studies

Two main study designs were identified among the eighteen publications selected in the systematic review. Height studies^(13–15,34,37–40) followed an interventional longitudinal protocol that involved a WL induced by diet from 3 weeks^(34,37) to 24 weeks^(13–15) duration in NW subjects, followed by a period of free-living or imposed recovery diet

during 14 d⁽³⁸⁾ to 40 weeks⁽⁴⁰⁾ (Table 1). Only one⁽⁴⁰⁾ of these studies included a control group without WL intervention, but results were thus not extracted as the mean BMI for this cohort was 27 kg/m² (overweight subjects). Two studies^(34,39) compared healthy young NW subjects with overweight and/or old ones (results were not extracted for these groups). Three studies^(34,37,39) imposed an individualised energy deficit of about 3 to 4 MJ/d (deficit of 800–1000 kcal/d). In Siggard *et al.*'s study⁽⁴⁰⁾, subjects received guidelines to set up an *ad libitum* high-carbohydrate and low-fat diet guarantying a minimum of 7 to 8 MJ/d (1670–1910 kcal/d). Fat was restricted to 20–25 % of daily energy intake, but subjects presented also an 11 % decrease in total energy intake⁽⁴⁰⁾. Finally, the other studies imposed a restricted standard daily food intake of 6.6 MJ/d (1570 kcal/d) in male subjects^(13–15) and below 5.0 MJ/d (1200 kcal/d) in female subjects⁽³⁸⁾. During the first 12-week recovery period (prior to *ad libitum* access to food), the

Table 1. Characteristics of the populations, description of the protocols, measurements and parameters, and main results linked to body weight changes of the interventional longitudinal studies selected in the systematic review

Reference	Characteristics of the groups	Interventional protocol	Measurements—parameters (method)	Main results
Dulloo <i>et al.</i> (1996)	Minnesota cohort n 32 (m) 25 ± 4 years (range: 20, 33) BMI NR	Pre-WL (12 weeks): weight maintenance with 14.6 MJ/d (12–13 % protein + 34–40 % fat + 47–54 % CHO) WL-1 (12 weeks) + WL-2 (12 weeks): 6.6 MJ/d (25 % protein + 17 % fat + 58 % CHO) WG (12 weeks): recovery-imposed diet of about 12.1 MJ/d (men were split into four groups of different degree of EI deficits) (12–17 % protein + 20 % fat + 63–68 % CHO) Subjects resided at the university during all the study with provided meals.	<u>Anthropometry/body composition:</u> BW; height; FM, FFM (hydrodensitometry); abdominal and arm circumferences <u>Energy expenditure:</u> REE (indirect calorimetry); $\Delta REE (= REE_{MEASURED} - REE_{PREDICTED})$	Pre-WL/WL-1/WL-2/WG ΔREE (MJ/d): -0.10 (range: $-0.84, +0.40$)/ NR/-1.96 (range: $-2.72, -0.90$)/-0.89 (range: $-1.88, 0$) → Positive correlation between ΔREE and FM recovery → Reduced thermogenesis = accelerated FM recovery Extracted from raw data[§]: BW (kg): $69.2 \pm 5.8/57.3 \pm 4.8^{***}/46.5 \pm 3.6^{***}/54.0 \pm 3.7^{***}$ FM (kg): $9.7 \pm 4.1/4.6 \pm 3.3^{***}/2.8 \pm 2.3^{***}/5.9 \pm 2.6^{***}$ FM (%): $13.7 \pm 5.0/7.8 \pm 5.2^{***}/5.8 \pm 4.5^{***}/10.9 \pm 4.5^{***}$ FFM (kg): $59.5 \pm 4.2/52.7 \pm 4.3^{***}/43.7 \pm 3.1^{***}/48.1 \pm 3.3^{***}$
Dulloo <i>et al.</i> (1997)	Minnesota cohort n 12 (m) 25 ± 4 years (range: 20, 33) BMI NR	Pre-WL (12 weeks): weight maintenance with 15.1 MJ/d (13 % protein + 37 % fat + 50 % CHO) WL-1 (12 weeks) + WL-2 (12 weeks): 6.6 MJ/d (25 % protein + 17 % fat + 58 % CHO) WG-1 (12 weeks): recovery imposed diet with range of 9.9–14.2 MJ/d (men were split into four groups of different degree of EI deficits) (12–17 % protein + 20 % fat + 63–68 % CHO) WG-2 (8 weeks): <i>ad libitum</i> EI (about 20.0 MJ/d) (14 % protein + 35 % fat + 51 % CHO) Subjects resided at the university during all the study with provided meals.	<u>Anthropometry/body composition:</u> BW; FM, FFM (hydrodensitometry); FFM and FM corrected for excess hydration (formula of Keys <i>et al.</i>) <u>Energy intake:</u> Food intake; control EI (= mean EI on the last 3 weeks of pre-WL period); weekly hyperphagia during WG-2 (= $EI_{WG-2} - control EI$)	Pre-WL/WL-1/WL-2/WG-1/WG-2 (week 1/week 2/.../week 8) FM (% of FM_{pre-WL}): 100/47/32/83 (range: 42, 148)/174 FFM (% of FFM_{pre-WL}): 100/87/83/88 (range: 84, 90)/98 FFM corrected (% of FFM_{pre-WL}): 100/NR/73/80/NR EI (% of EI_{pre-WL}): 100/45/44/101/(148/165/149/141/119/108/106) → Negative correlation of hyperphagia (EI during WG-2) with the degree of FM recovery, FFM recovery and EI deficit at WG-1 → The 6 men in the 2 lower-EI groups at WG-1 gained 4.6 kg more at WG-2 than the 6 men in the upper-EI groups at WG-1 Extracted from raw data[§]: BW (kg): $67.4 \pm 5.1/55.8 \pm 4.2^{***}/45.7 \pm 3.0^{***}/53.5 \pm 3.5^{***}/70.5 \pm 4.4^{***}$ FM (kg): $8.9 \pm 4.6/4.5 \pm 4.0^{***}/2.8 \pm 2.7^{***}/6.4 \pm 3.3^{***}/13.5 \pm 3.0^{***}$ FM (%): $12.9 \pm 5.7/7.7 \pm 6.1^{***}/5.9 \pm 5.0^{***}/11.7 \pm 5.5/19.0 \pm 3.3^{***}$ FFM (kg): $58.5 \pm 3.3/51.3 \pm 2.9^{***}/42.9 \pm 2.0^{***}/47.1 \pm 2.7^{***}/57.0 \pm 3.2^*$

Table 1. (Continued)

Reference	Characteristics of the groups	Interventional protocol	Measurements—parameters (method)	Main results
Dulloo <i>et al.</i> (1998)	Minnesota cohort n 32 (m) 25 ± 4 years (range: 20, 33) BMI NR	Pre-WL (12 weeks): weight maintenance with 15.1 MJ/d (13 % protein + 37 % fat + 50 % CHO) WL-1 (12 weeks) + WL-2 (12 weeks): 6.6 MJ/d (25 % protein + 17 % fat + 58 % CHO) WG (12 weeks): recovery-imposed diet with range of 9.9–14.2 MJ/d (men were split into four groups of different degree of EI deficits) (12–17 % protein + 20 % fat + 63–68 % CHO) Subjects resided at the university during all the study with provided meals.	Anthropometry/body composition: BW; FM, FFM (hydrodensitometry); FFM corrected for excess hydration (formula of Keys <i>et al.</i>) Energy expenditure: REE (indirect calorimetry); ΔAdjustedREE (for FM and FFM)	See Dulloo <i>et al.</i> 1996 for BW (kg), FM (kg and %), and FFM (kg) Pre-WL/WL-1/WL-2/WG REE (MJ/d): 6.73 ± 0.40/4.57 ± 0.44***/ 4.10 ± 0.41***/5.40 ± 0.47** ΔAdjustedREE (MJ): N/A/–1.49 ± 0.51/– 1.71 ± 0.48/–0.69 ± 0.46 ΔAdjustedREE (% of pre-WL): N/A/–21.5 ± 6.9/ 24.7 ± 6.2/–9.7 ± 6.6
Heyman <i>et al.</i> (1992)	n 7 (m) 20.8 ± 1.3 years 22.6 ± 1.9 kg/m ²	Pre-WL-1: baseline Pre-WL-2 (10 d): weight maintenance (protein: 1.5 g/d/kg of BW + 45 % fat and 55 % CHO for the non-protein macronutrients) including normal food items and a palatable low-protein liquid supplement (< 1 % protein + 45 % fat + 55 % CHO) WL-1 (10 d) + WL-2 (10 d): –3.35 MJ/d of EI _{pre-WL} (EI similarly to pre-WL but without the palatable liquid supplement) WG-1 (10 d): <i>ad libitum</i> EI with specific instructions to consume as much or as little food and drink as they required to feel normally satiated and to not change their diet to gain the weight previously lost. Subjects were asked to not weigh themselves WG-2 (37 d): <i>ad libitum</i> EI without specific instructions Meals and energetic beverages were provided by the research centre (except for WG-2). They were encouraged to pursue a normal lifestyle during the study. Physical activity was monitored but not restricted.	Anthropometry/body composition: BW; height; BMI; waist, hip, mid-upper arm, thigh, and calf circumferences; skinfolds; FFM and FM (doubly labelled water; only for pre-WL and WL) Energy intake: Food intake (weighed food during each phase except WG-2); metabolisable energy (digestible EI from faecal samples); energy excess during WG (calculated as: Metabolisable energy–TEE) Energy expenditure (only at pre-WL and WL): TEE (doubly labelled water); fasting REE (indirect calorimetry); post-prandial REE (indirect calorimetry); respiratory quotient (indirect calorimetry); PA (trunk monitor, wrist motion sensor, and self-reported record for strenuous physical activity)	Pre-WL-1/Pre-WL-2/WL-1/WL-2/WG-1/WG-2 Food intake (MJ/d): N/A/15.9 ± 4.1/13.1 ± 4.1***/ 13.1 ± 4.1***/18.1 ± 2.7**/NR Metabolisable energy (MJ/d): N/A/15.3 ± 3.6/ 12.0 ± 3.6***/12.0 ± 3.6***/16.9 ± 2.5/NR BW (kg): 69.2 ± 11.1/69.7 ± 10.6/NR/NR**/ 70.3 ± 10.9/70.5 ± 11.1 ΔBW (kg): N/A/+0.65 ± 0.67/–0.23 ± 0.78/– 1.41 ± 1.03/+1.19 ± 1.17/+1.43 ± 1.31 → Positive correlation between the WL (kg) and the energy excess during WG → FM and FFM stores were estimated to constitute 50 % and 10 %, respectively, of WL Pre-WL/WL-1/WL-2 (statistical differences with pre-WL were measured from values for mean WL-1 + WL-2) FM (%): 13.2 ± 4.0/11.9 ± 4.5/12.4 ± 4.0 Fasting REE (MJ/d): 7.22 ± 0.92/6.94 ± 0.96**/ 6.93 ± 0.90** Relative fasting REE (MJ/kg of FFM/d): 0.12 ± 0.01/0.12 ± 0.01*/0.12 ± 0.01* TEE (MJ/d): 15.35 ± 3.50/14.66 ± 3.81/ 13.56 ± 3.68 Reported strenuous PA (min/d): 40.8 ± 22.5/ 43.8 ± 11.9/36.2 ± 12.7 Pre-WL/WL-1/WG-1/WL-2/WG-2 BW (kg)±: 52.1 ± 4.3/47.7 ± 4.3†/53.3 ± 4.0†/ 48.7 ± 4.0†/51.7 ± 4.3 ΔBW (kg) (%FM and %FFM lost)^{NAS}: N/A/–4.42 kg (–72 % FM, –28 % FFM)/+5.61 kg (+55 % FM, +45 % FFM)/–4.55 kg (–59 % FM, –41 % FFM)/+2.94 kg (+95 % FM, +5 % FFM) FM (%): 23.6 ± 3.8/19.1 ± 4.9***/22.9 ± 2.9/ 19.5 ± 4.0***/23.8 ± 4.2 ΔFM (%): N/A/–3.1 ± 0.7/–0.1 ± 0.9/–2.7 ± 0.7/+ 0.1 ± 1.6 FFM: NR/NR***/NR/NR**/NR** ΔFFM (kg): N/A/–1.2 ± 0.7/+1.3 ± 0.7/–0.5 ± 0.7/ –0.4 ± 0.7
Kajiooka <i>et al.</i> (2001)	n 5 (f) 24.6 ± 5.5 years (range: 22, 34) 20.5 ± 1.1 kg/m ² Non-smokers, no oral contraceptive.	Pre-WL: baseline WL-1 (30 d): max 5.0 MJ/d WG-1 (14 d): <i>ad libitum</i> EI WL-2 (30 d): max 5.0 MJ/d WG-2 (106 d): <i>ad libitum</i> EI Free-living lifestyle. Subjects were supervised by a dietitian, cooked her meals herself and estimated their EI, notably with a nutritional balance. PA: regular exercise prohibited during all the study.	Anthropometry/body composition: BW; height; BMI; waist and hip circumferences; FM (plethysmography); FFM (BW–FM) Energy expenditure: REE (indirect calorimetry) Biological parameters: Lipoprotein lipase (only at pre-WL, WL-2 and WG-2), total cholesterol, TAG, HDL, LDL, T3, T4, thyroid-stimulating hormone (fasting blood samples); sitting systolic and diastolic blood pressure (sphygmomanometer)	

Dieting in normal-weight individual

Table 1. (Continued)

Reference	Characteristics of the groups	Interventional protocol	Measurements—parameters (method)	Main results
Moriguti <i>et al.</i> (2000)	<i>n</i> 11 (5 m + 6 f) 25.7 ± 3.2 years 23.2 ± 1.6 kg/m ² (range: 18, 24) Data were extracted only for the NW subjects' group.	Pre-WL (2 weeks): weight maintenance (13% protein + 35% fat + 52% CHO) WL (6 weeks): -4.2 MJ/d from fat and CHO of EI _{pre-WL} WG-1 (6 weeks) + WG-2 (6 weeks) + WG-3 (6 weeks) + WG-4 (6 weeks): <i>ad libitum</i> EI without specific instructions Meals and energetic beverages were provided by the research centre (except for the last 22 weeks of WG). They were encouraged to pursue a normal lifestyle during the study and to maintain their PA level (no change was observed between pre-WL and WL).	Anthropometry/body composition: BW; height; BMI; FFM and FM (hydrodensitometry) Energy intake: Energy excretion (3-d faecal collection at pre-WL and WL); dietary compliance (osmolar excretion rate from urine samples at WL); frequency of hunger, satiety, thirst, and constipation (5-point scale, at pre-WL and WL) Energy expenditure: PA level (7-d waist monitor, and self-reported record for strenuous physical activity; at pre-WL and WL)	Waist and hip circumferences, ratio waist/hip: pre-WL = WG-2 REE: Pre-WL > (WL-1, WL-2, WG-2) ^{***} , Pre-WL < WG-1 ^{***} (absolute values NR) ΔREE (MJ): N/A/-1.00 ± 0.26/+0.19 ± 0.62/-0.80 ± 0.52/-0.99 ± 0.80 (-15.8%) Biological parameters: - Lipoprotein lipase: NS - Total cholesterol: pre-WL > WG-1, pre-WL < WL-2, pre-WL = WL-1 = WG-2 - TAG: pre-WL = WL, pre-WL < WG - LDL: pre-WL = WL-1 = WG, pre-WL < WL-2 - HDL: pre-WL = WL = WG-2, pre-WL < WG-1 - T3, T4: pre-WL > WL and WG - Thyroid-stimulating hormone: pre-WL > WL-1, pre-WL = WG = WL-2 Pre-WL/WL^{NAS} Food intake (MJ/d): 11.6 ± 2.7/8.0 ± 3.2 Energy excretion (MJ/d): 0.33 ± 0.23/0.54 ± 0.36 Relative energy excretion (% of EI): 2.6 ± 3.7/5.5 ± 3.0 WL/WG-1/WG-2/WG-3/WG-4 BW (kg): NR ^{***} /NR [*] /NR/NR ΔBW(kg): -3.13 ± 1.13/-1.62 ± 1.36/-1.47 ± 1.44/-0.27 ± 1.97/-0.28 ± 2.32 ΔFM(kg): -1.77 ± 1.29/NR/NR/NR/-0.05 ± 1.69 ΔFFM(kg): -1.35 ± 0.96/NR/NR/NR/-0.23 ± 1.56 → NW subjects regaining significantly more BW than OW (Time × Group effect, <i>P</i> < 0.001)
Roberts <i>et al.</i> (1994)	<i>n</i> 10 (m) 22.0 ± 3.0 years 22.8 ± 1.8 kg/m ² Non-smokers, no history of endocrinopathy. Data were extracted only for the young subjects' group.	Pre-WL (10 d): weight maintenance (protein: 1.5 g/d/kg of BW + 45% fat and 55% CHO for the non-protein macronutrients) WL-1 (9 d) + WL-2 (12 d): -3.3 MJ/d of EI _{pre-WL} (protein: 1.5 g/d/kg of BW + 45% fat and 55% CHO for the non-protein macronutrients) WG-1 (10 d): <i>ad libitum</i> EI with specific instructions to not change the composition of food intake. Subjects were asked to not weigh themselves WG-2 (36 d): <i>ad libitum</i> EI without specific instructions Meals and energetic beverages were provided by the research centre, and for WG-2 phase, subjects were permitted to consume additional energetic beverages. They were encouraged to pursue a normal lifestyle during the study.	Anthropometry/body composition: BW; height; BMI; FFM (doubly labelled water); FM (BW-FFM) Energy intake: Food intake (weighed food during pre-WL, WL and WG-1); metabolisable energy (digestible EI from faecal samples) Energy expenditure: TEE (doubly labelled water); REE (indirect calorimetry); strenuous PA (self-reported on sheet)	Pre-WL/WL (1 and 2)/WG-1/WG-2 Metabolisable energy (MJ/d): 14.07 ± 2.20/NR/NR [*] /N/A BW (kg): NR/NR [†] /NR/NR FFM (kg): 58.4 ± 9.7/NR/NR/NR FM (%): 15.7 ± 6.2/NR/NR/NR TEE (MJ/d): 14.48 ± 2.68/NR/NR/NR Strenuous PA (min/d): 29.2 ± 24.5/NR/NR/NR WL-1/WL-2/WG-1/WG-2 ΔBW (kg): -0.7 ± 0.9/-1.6 ± 1.3/+0.5 ± 0.9/+1.1 ± 0.9 WG-1 (days 1 to 10) ΔFood intake (%): +33.1 ± 22.1/+16.9 ± 18.7/+18.0 ± 24.3/+14.2 ± 20.2/+13.9 ± 17.4/+10.9 ± 12.3/+20 ± 18.3/+17.8 ± 14.2/+16.9 ± 25.3/+14.2 ± 20.6 → Negative correlation between initial FM (%) and EI at WG-1

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Table 1. (Continued)

Reference	Characteristics of the groups	Interventional protocol	Measurements—parameters (method)	Main results
Siggaard <i>et al.</i> (1996)	<i>n</i> 18 (17 m + 1 f) 34.7 ± 11.0 years 23.8 ± 1.3 kg/m ² (range: 22.0, 24.9) <i>n</i> 3 smokers, <i>n</i> 10 with previous history of dieting, <i>n</i> 8 who exercised (2 times/week) Data were extracted only for the NW subjects' group.	Pre-WL: baseline (measured EI = 8.5 ± 1.3 MJ/d) WL-1 (6 weeks) + WL-2 (6 weeks): <i>ad libitum</i> high-CHO and low-fat diet. Subjects received a dietary guideline guaranteed a minimum of 7.0 to 8.0 MJ/d (15–20% protein + 20–25% fat + 60–65% CHO) WG-1 (12 weeks) + WG-2 (28 weeks): subjects were encouraged to maintain the <i>ad libitum</i> high-CHO and low-fat diet and not to begin other diets No change of smoking status or PA level was observed during the study.	Anthropometry/body composition: BW; height; BMI; FFM and FM (bioimpedance, only at pre-WL, WL-1 and WL-2); waist and hip circumferences (only at pre-WL and WL-2) Energy intake: Food intake (4-d food record at pre-WL and probably at the beginning of WG-1); history of dieting (questionnaire) Energy expenditure (only at pre-WL and WL-2): PA level (questionnaire) Others (only at pre-WL and WL-2): Smoking status (questionnaire)	WL-1/WL-2/WG-1/WG-2 ^{NAS} ΔBW (kg): -1.86 ± 1.31/-2.5 ± 1.7 (-3.7% of BW _{pre-WL}) (NW < OW)/-1.96 ± 1.31/-1.69 ± 1.26 (time effect: <i>P</i> < 0.05) WL > 5 kg (% of sample): NR/11%/0%/0% 2.5–5 kg WL (% of sample): NR/44%/25%/25% 0–2.5 kg WL (% of sample): NR/39%/42%/50% WG (% of sample): NR/6%/33%/25% ΔBMI (kg/m²): -0.7 ± 0.4 (NW = OW)/-0.9 ± 0.4 (NW < OW)/NR/NR ΔFM (kg): -1.9 ± 1.3 (NW < OW)/-2.8 ± 1.7 (NW < OW)/NR/NR ΔFM (%): -1.9 ± 2.1 (NW < OW)/-3.2 ± 1.7 (NW < OW)/NR/NR ΔFFM (kg): +0.3 ± 1.2/+0.6 ± 1.4/NR/NR ΔWaist-hip ratio: -0.01 ± 0.04/-0.01 ± 0.04/NR/NR No apparent statistical for pre-WL v. WL or WG measures

m, males; NR, not reported; WL, weight loss; CHO, carbohydrates; WG, weight gain; EI, energy intake; BW, body weight; FM, fat mass; FFM, fat-free mass; REE, resting energy expenditure; TEE, total energy expenditure; f, females; T3, triiodothyronine; T4, thyroxine; NAS, no apparent statistical between pre-WL and WL or WG measures; NS, no significant; NW, normal-weight group; OW, overweight group; PA, physical activity; *italic*, values collected from graphs; Δ, change from pre-WL measure.

Results are expressed in mean and standard deviation.

* *P* < 0.05,

** *P* < 0.01,

*** *P* < 0.001, significantly different from pre-WL measure.

† Significantly different from pre-WL but *P*-value not reported.

‡ Statistical unclear.

§ Statistical performed from raw data (repeated-measures ANOVA).

Dieting in normal-weight individual

Table 2. Characteristics of the populations, time points assessments, measurements and parameters assessed in the observational studies

Reference	Characteristics of the groups (sample size (sex); initial age; BMI)	Time points measurements	Measurements–parameters (method)
Anastasiou <i>et al.</i> (2010)	<i>Cohort of adults from Greece</i> High-body-fat (FM > 30 %) (HF) <i>n</i> 15 (f); 21.1 ± 1.9 years; 22.7 ± 1.9 kg/m ² ** Low-body-fat (FM < 30 %) (LF) <i>n</i> 17 (f); 22.1 ± 3.3 years; 19.8 ± 0.8 kg/m ² **	N/A (cross-sectional study)	<u>Anthropometry/body composition:</u> BW; height; waist and hip circumferences; FM, FFM (DXA) <u>Energy intake, dietary and eating behaviours:</u> Food intake (24-h food record); weight cycling (25-item Weight Cycling Questionnaire that includes the EAT-26 questionnaire); accuracy of reporting food intake (food intake/REE ratio, < 0.9 = under-reporter of self-reported food intake) <u>Energy expenditure:</u> PAEE (Harokopio Physical Activity Questionnaire); REE (equation of Schofield); TEE <u>Physical condition:</u> Aerobic capacity (Astrand test) <u>Biological parameters:</u> Glucose, TAG, FFA, total cholesterol, HDL, LDL, insulin (fasting blood samples); OGTT; HOMA
Colditz <i>et al.</i> (1990)	<i>Nurses' Health Study cohort (USA)</i> <i>n</i> 31 940 (f); range: 30, 54 years; NR Smokers, pregnant women, women who consumed > 15 g alcohol/d, women with special diets and women with prior diagnosis of cardiometabolic disease were excluded (during all the follow-up).	Total: 8 years T0: baseline T1: 2 years T2: 4 years T3: 6 years T4: 8 years	<u>Anthropometry/body composition:</u> BW (self-reported and measured for <i>n</i> 184); height (self-reported) <u>Energy intake, dietary and eating behaviours (only at T2):</u> Food intake (FFQ, 1-week food record for <i>n</i> 194)
Karkkainen <i>et al.</i> (2018)	<i>FinnTwin16 cohort (Finland)</i> m maintainers <i>n</i> 513 (m); 24 years; 24.2 ± 2.9 kg/m ² m gainers <i>n</i> 1630 (m); 24 years; 23.7 ± 3.0 kg/m ² f losers <i>n</i> 185 (f); 24 years; 23.9 ± 3.7 kg/m ² f maintainers <i>n</i> 701 (f); 24 years; 21.8 ± 3.1 kg/m ² f gainers <i>n</i> 1566; 24 years; 22.1 ± 3.5 kg/m ² NAS for groups differences Participants are defined like 'maintainers' if their BW at T1 was within ± 5 % of their BMI at T0. Subjects suffering from chronic, potentially weight-affecting illness at T0 and T1 were excluded.	Total: 10 years T0: baseline T1: 10 years	<u>Anthropometry/body composition:</u> BW; height; waist circumference (self-reported); BMI <u>Energy intake, dietary and eating behaviours (only at T0):</u> Intentional WL ≥ 5 kg (1 question); regularity of eating and eating styles (self-reported questionnaire developed by Keski-Rahkonen, 2007); daily breakfast (1 question); food and fluid intake (FFQ); eating behaviours (bulimia subscale of EDI) <u>Energy expenditure (only at T0):</u> PAEE (self-reported) <u>Others (only at T0):</u> Life satisfaction (Allardt's four-item scale); self-rated health (one question); education level
Korkeila <i>et al.</i> (1999)	<i>FinnTwin16 cohort (Finland)</i> m non-dieters <i>n</i> 1731 (m) (T2: <i>n</i> 1120); range: 18, 29 years; 22.2 ± 2.1 kg/m ² ** m dieters <i>n</i> 142 (m) (T2: <i>n</i> 99); range: 18, 29 years; 24.3 ± 2.3 kg/m ² ** f non-dieters <i>n</i> 1811 (f) (T2: <i>n</i> 1294); range: 18, 29 years; 20.3 ± 2.1 kg/m ² ** f dieters <i>n</i> 475 (f) (T2: <i>n</i> 329); range: 18, 29 years; 22.6 ± 2.2 kg/m ² ** Pregnant women were excluded.	Total: 15 years T0: baseline T1: 6 years T2: 15 years	<u>Anthropometry/body composition:</u> BW; height (self-reported and measured for <i>n</i> 225 at T2); BMI <u>Energy intake, dietary and eating behaviours (only at T0):</u> WL attempts (questionnaire) <u>Energy expenditure (only at T0):</u> PAEE (self-reported) <u>Others (only at T0):</u> Smoking status, alcohol consumption, education level, social class and marital status (questionnaire)

Table 2. (Continued)

Reference	Characteristics of the groups (sample size (sex); initial age; BMI)	Time points measurements	Measurements—parameters (method)
Lowe <i>et al.</i> (2006)	<p><i>Cohort of American first-year college students</i></p> <p>Dieters (past + current) n 29 (f); NR; NR</p> <p>Non-dieters n 40 (f); NR; NR</p> <p>Total groups n 69 (f); 18.1 ± 0.2 year (range: 18, 19); 21.9 ± 2.4 kg/m² (range: 17.4, 26.6)</p> <p>Any medications known to affect appetite or weight excluded, no eating disorder in the year prior the study.</p>	<p>Total: 8 months</p> <p>T0: baseline T1: 3 weeks T2: 4 months T3: 8 months</p>	<p><u>Anthropometry/body composition:</u> BW; height; BMI; highest BW in life (self-reported)</p> <p><u>Energy intake, dietary and eating behaviours (only at T1):</u> Dieting history and restraint behaviours (10-item Restraint Scale, Classification of Lowe, 1993); BW suppression (= BW_{T0} – Highest BW in life); eating behaviours (TFEQ and DEBQ)</p>
Palascha <i>et al.</i> (2015)	<p><i>Cohort of Dutch adults</i></p> <p>n 241 (49 m + 192 f); 32.3 ± 15.3† years (range: 15, 74); 23 ± 4.5† kg/m²</p> <p>No specific inclusion or exclusion criteria.</p>	N/A (cross-sectional study)	<p><u>Anthropometry/body composition:</u> BW, height (self-reported); BMI</p> <p><u>Energy intake, dietary and eating behaviours:</u> Eating behaviours (Restraint Eating subscale of DEBQ); dichotomous thinking regarding food and dieting (eleven-item Dichotomous Thinking in Eating Disorders Scale); WL during the last 5 years (yes/no, no distinction between voluntary or involuntary WL); weight regain of 4 kg or more following WL (yes/no); dieting (yes/no)</p> <p><u>Others:</u> Dichotomous thinking regarding general personality (fifteen-item Dichotomous Thinking Inventory); education level</p>
Pietiläinen <i>et al.</i> (2012)	<p><i>FinnTwin16 cohort (Finland)</i></p> <p>n 4129 (1922 m + 2207 f); 18 years; At 16 years; m: 20.4 kg/m², f: 20.2 kg/m²</p> <p>Study started at 16 years, but results were extracted from 18 years (T0) for subjects with intermediate basal BMI (25th percentile–75th percentile)</p> <p>Subjects with diabetes mellitus, systemic lupus erythematosus, inflammatory bowel disease, celiac disease, hyper- or hypo-thyroidism, malignancies, mobility disorders, eating disorders or with medication affecting BW were excluded.</p>	<p>Total: 7 years</p> <p>T0: baseline T1: 7 years</p>	<p><u>Anthropometry/body composition:</u> BW, height (self-reported and measured for n 566); BMI; late physical maturity (growth in height between 16 and 18 years)</p> <p><u>Energy intake, dietary and eating behaviours:</u> Number of intentional WL ≥ 5 kg (one question at T1); daily breakfast (one question)</p> <p><u>Energy expenditure:</u> PAEE (questionnaire)</p> <p><u>Others:</u> Smoking status (questionnaire); number of children (question at T1); parental BMI, father's socio-economic status (questionnaire at 16 years)</p>
Sares-Jäske <i>et al.</i> (2019)	<p><i>Health Survey cohort (Finland)</i></p> <p>n 2785 (1268 m + 1517 f); 47.2 ± 10.2 years (range: 30, 69); 26.5 ± 4.4 kg/m²</p> <p>Weight changes were analysed by BMI categories.</p> <p>Pregnant women at T0 and/or T1 were excluded.</p>	<p>Total: 11 years</p> <p>T0: baseline T1: 11 years</p>	<p><u>Anthropometry/body composition:</u> BW; height; waist circumference</p> <p><u>Energy intake, dietary and eating behaviours:</u> Dieting attempts, WL and WG history during the previous year (questionnaire at T0); food intake (FFQ); diet quality (Alternate Healthy Eating Index modified for Finnish dietary culture)</p> <p><u>Energy expenditure:</u> PAEE (questionnaire)</p> <p><u>Biological parameters:</u> Blood pressure</p> <p><u>Others:</u> Mental disorders (DSM-IV and Interview); burnout (Maslach Burnout Inventory, in subjects who had been working during the last 12 months); marital status, education, smoking status, cancer diagnosis, self-rated health (interview); alcohol consumption (questionnaire); sense of coherence (Antonovsky's SOC-13 scale); type 2 diabetes diagnosis (interview, health examination and questionnaire); knee or hip arthrosis (health examination)</p>

Dieting in normal-weight individual

Table 2. (Continued)

Reference	Characteristics of the groups (sample size (sex); initial age; BMI)	Time points measurements	Measurements—parameters (method)
van Strien <i>et al.</i> (2014)	<p><i>Cohort of Dutch adults</i> Extracted from raw data at T0 for NW participants</p> <p>m dieters <i>n</i> 8; NR; 23.43 ± 1.60 kg/m²</p> <p>m non-dieters <i>n</i> 160; NR; 22.86 ± 1.64 kg/m²</p> <p>f dieters <i>n</i> 21; NR; 22.95 ± 1.39 kg/m²</p> <p>f non-dieters <i>n</i> 152; NR; 22.39 ± 1.65 kg/m²</p> <p>Total groups <i>n</i> 341 (168 m + 173 f); 47.8 ± 14.4 years; 22.67 ± 0.30 kg/m² Underweight subjects were excluded.</p>	<p>Total: 1.5 years</p> <p>T0: baseline T1: 4 months T2: 12 months T3: 16 months</p>	<p><u>Anthropometry/body composition:</u> BW, height (self-reported)</p> <p><u>Energy intake, dietary and eating behaviours:</u> Dieting status (Restraint Scale, nine-item)</p> <p><u>Energy expenditure:</u> PAEE in summer and winter (self-reported)</p>
van Wye <i>et al.</i> (2012)	<p><i>Aerobics Center Longitudinal Study cohort (USA)</i></p> <p>Weight cyclers (WC) (minimum 5 WL episodes of ≥ 2.3 kg) <i>n</i> 68 (f); 45.4 ± 7.8 years; 23.4 ± 4.0 kg/m²*</p> <p>Non-cyclers (NC) <i>n</i> 73 (f); 47.9 ± 10.5 years; 21.4 ± 2.2 kg/m²* Subjects who reported unintentional WL at T0 were excluded.</p>	<p>Total: 6 years</p> <p>T0: baseline T1: 6 years</p>	<p><u>Anthropometry/body composition:</u> BW; height; BMI; FM (method NR)</p> <p><u>Energy intake, dietary and eating behaviours:</u> Weight cycling (one question adapted from the Brownell Weight Cycling Questionnaire at T0); dieting status (method NR, probably one question)</p> <p><u>Physical condition:</u> Aerobic capacity (maximal exercise treadmill)</p> <p><u>Others:</u> Smoking status (method NR, probably one question); marital status, chronic disease, depression and level of perceived tension/anxiety (questions)</p>

FM, fat mass; HF, high-body fat group; f, females; LF, low-body fat group; BW, body weight; FFM, fat-free mass; DXA, dual-energy X-ray absorptiometry; EAT-26, 26-item Eating Attitudes Test; REE, resting energy expenditure; PAEE, physical activity energy expenditure; TEE, total energy expenditure; FFA, fat-free acids; OGTT, oral glucose tolerance test; HOMA, homeostatic model assessment of insulin resistance; NR, not reported; m, males; NAS, no apparent statistical; WL, weight loss; EDI, Eating Disorder Inventory; TFEQ, Three-Factors Eating Questionnaire; DEBQ, Dutch Eating Behavior Questionnaire; WG, weight gain; DSM-IV, Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition; WC, weight-cyclers; NC, non-cyclers.

Results are expressed in mean and standard deviation.

* $P < 0.05$,

** $P < 0.001$, dieters v. non-dieters or HF v. LF or WC v. NC.

† No information about the nature of data (SD or SEM).

Table 3. Main results of the observational studies selected in the systematic review, classified as three subgroups: results relative to dietary habits and weight loss (food intake, dietary and WL), main results on body weight and body composition, and additional results in link with body weight changes and/or diet

Reference	Food intake, dietary and WL	Main results on BW and/or body composition	Additional results
Anastasiou <i>et al.</i> (2010)	<p><u>Food intake (MJ/d):</u> HF: 7.3 ± 2.8* LF: 9.4 ± 3.7*</p> <p><u>Macronutrients:</u> HF = LF</p> <p><u>Accuracy of reporting food intake (food intake/REE ratio):</u> HF: 1.2 ± 0.4* (40%* of under-reporters) LF: 1.8 ± 0.8* (6%* of under-reporters)</p> <p><u>Dieting frequency (% sample):</u> HF: 13% Never, 53% Seldom, 13% Sometimes, 20% Frequently LF: 65% Never, 12% Seldom, 18% Sometimes, 6% Frequently</p> <p>Interaction between group and diet frequency ($P < 0.05$)</p> <p><u>Number of WL per year:</u> - 2–3 kg: HF > LF - > 5 kg: HF = LF</p> <p><u>Number of WL per lifetime:</u> - 1.0–2.5 kg, 3.0–5.0 kg, > 6 kg: HF = LF</p>	<p><u>BW (kg); height (cm); FM (%):</u> HF: 64.1 ± 7.4 kg*; 169 ± 15 cm*; 34.9 ± 3.9%*** LF: 53.3 ± 4.1 kg*; 164 ± 13 cm*; 26.2 ± 2.5%***</p> <p>→ Losing 1.0 to 2.5 kg per lifetime = ↗ the risk of high FM → Higher BW and TAG levels = \ insulin sensitivity</p>	<p><u>Eating behaviours:</u> Satisfied body size and image: HF < LF Oral control score, bulimia scale, total EAT-26 score: HF = LF Dieting scale: HF > LF</p> <p><u>Energy expenditure:</u> TEE: HF > LF</p> <p><u>Physical condition:</u> Aerobic capacity: HF < LF</p> <p><u>Biological parameters:</u> OGTT (glucose and insulin), TAG, FFA, total cholesterol, HDL, LDL: HF = LF Insulin/glucose: HF > LF Fasting insulin and glucose: HF > LF****</p>
Colditz <i>et al.</i> (1990)	<p><u>At T1</u></p> <p><u>Food intake (n in sample)^{NAS}:</u> - ≤ 5.0 MJ/d: n 7578 -]5.0–7.7] MJ/d: n 15 938 - > 7.7 MJ/d: n 8399</p> <p><u>CHO (n in sample)^{NAS}:</u> - ≤ 114 g/d: n 8336 - [115–18] g/d: n 16 020 - > 189 g/d: n 7584</p> <p><u>Fat (n in sample)^{NAS}:</u> - ≤ 49 g/d: n 8149 - [50–85] g/d: n 16 019 - > 85 g/d: n 7772</p> <p><u>Protein (n in sample)^{NAS}:</u> - ≤ 56 g/d: n 8182 - [56–87] g/d: n 15 701 - > 87 g/d: n 8057</p>	<p><u>BW or ΔBW (kg):</u> <u>In function of weight change from T0 to T2 (T2/ ΔT2-T4)^{NAS}:</u> - WL > 5 kg (n 944): 66.16 ± 13.17/+5.79 ± 7.08 - WL = 3–5 kg (n 1300): 62.83 ± 10.35/+3.46 ± 4.62 - WL = 3 kg–WG = 3 kg (n 19 988): 61.68 ± 9.53/+1.54 ± 3.57 - WG = 3–4.9 kg (n 5178): 67.21 ± 10.36/+1.09 ± 4.36 - WG = 5–9.9 kg (n 3407): 74.19 ± 11.73/+1.02 ± 5.65 - WG > 10 kg (n 1123): 87.88 ± 14.74/–0.16 ± 9.06</p> <p><u>In function of food intake at T0 (T1/ ΔT1-T2/ ΔT2-T4)^{NAS}:</u> - ≤ 5.0 MJ/d (n 8578): 63.4/+0.35 ± 1.8/+0.41 ± 1.2 -]5.0–7.7] MJ/d (n 15 938): 64.0/+0.44 ± 1.7/+0.38 ± 1.1 - > 7.7 MJ/d (n 8399): 65.1/+0.51 ± 1.8/+0.38 ± 1.2</p>	N/A
Karkkainen <i>et al.</i> (2018)	<p><u>At T0 (recalculated data)</u></p> <p><u>Participants with history of WL ≥ 5 kg (% of sample)^{NAS}:</u> m maintainers: 6% m gainers: 12% f losers: 27% f maintainers: 14% f gainers: 18%</p> <p><u>Participants who daily breakfast (% of sample)^{NAS}:</u> m maintainers: 51% m gainers: 48% f losers: 61%</p>	<p><u>BW or ΔBW (kg) (T0/ ΔT0–T1)^{NAS}:</u> m maintainers: 78.4 ± 10.9/+1.0 ± 2.3 m gainers: 76.2 ± 11.5/+10.3 ± 6.3 f losers: 66.0 ± 10.7/–5.6 ± 3.8 f maintainers: 60.4 ± 9.2/+0.4 ± 1.8 f gainers: 60.6 ± 10.4/+9.2 ± 6.3</p> <p><u>Waist circumference or ΔWaist circumference (cm) (T0/ ΔT0–T1)^{NAS}:</u> m maintainers: 85.3 ± 8.8/+3.0 ± 5.2 m gainers: 85.1 ± 9.1/+10.1 ± 7.4 f losers: 78.7 ± 9.7/–2.4 ± 8.2 f maintainers: 73.4 ± 7.9/+3.3 ± 6.9 f gainers: 74.7 ± 9.6/+10.0 ± 8.3</p>	<p><u>Control of eating (% of sample at T0)^{NAS}:</u> m maintainers: 21% overeating, 2% restrictive, 1% restrictive and overeating m gainers: 13% overeating, 3% restrictive, 1% restrictive and overeating f losers: 30% overeating, 17% restrictive, 8% restrictive and overeating f maintainers: 22% overeating, 12% restrictive, 6% restrictive and overeating f gainers: 23% overeating, 12% restrictive, 6% restrictive and overeating</p>

Dieting in normal-weight individual

Table 3. (Continued)

Reference	Food intake, dietary and WL	Main results on BW and/or body composition	Additional results
	<p>f maintainers: 64 % f gainers: 58 % <u>Regularity of eating (% of sample)^{NAS}:</u> m maintainers: 13 % regular, 59 % quite regular, 24 % quite irregular, 4 chaotic % m gainers: 9 % regular, 55 % quite regular, 29 % quite irregular, 11 % chaotic f losers: 8 % regular, 52 % quite regular, 33 % quite irregular, 6 % chaotic f maintainers: 8 % regular, 59 % quite regular, 22 % quite irregular, 10 % chaotic f gainers: 6 % regular, 57 % quite regular, 27 % quite irregular, 9 % chaotic</p>	<p>Factors associated with weight maintenance or WG: m: OW at T0 = \ risk of WG; underweight at T0 = / risk of WG; irregular eating, dieting and smoking were associated with WG; higher baseline BMI and higher education level were associated with weight maintenance. f: OW at T0 = / risk of WG; sweet drinks, irregular eating, history of dieting, smoking, low satisfaction life, having two or more children were associated with WG; physical activity was associated with weight maintenance.</p>	
Korkeila <i>et al.</i> (1999)	<p><u>Frequency of dieting:</u> - Smokers > non-smokers - Subjects with highest alcohol consumption > others - Men in upper social classes > men in lower social classes - High energy expenditure during leisure time and heavy PA work were associated with likelihood of dieting.</p>	<p><u>ΔBW(kg) (ΔT0–T1/ ΔT0–T2):</u> m non-dieters: +3.60 ± 5.4/+7.45 ± 7.7**** m dieters: +3.65 ± 5.5/+8.89 ± 7.7**** f non-dieters: +2.26 ± 4.7/+6.23 ± 7.6 f dieters: +1.91 ± 4.8/+6.14 ± 7.6 <u>Frequency (% of sample) of WG > 10kg (T1/T2):</u> m non-dieters: 9%/29 % m dieters: 12%/36 % f non-dieters: 4%/22 % f dieters: 7%/25 % <u>Factors associated with BMI at T0:</u> - Smokers > non-smokers - Men with high alcohol consumption > men with low alcohol consumption - Married women > single women/married men = single men - Negative correlation of education level and social class with BMI - Positive correlation between work PA work and BMI - No correlation of PA during leisure time and BMI</p>	<p><u>Frequency (% of sample) of WG > 10 kg in function of BMI_{T0} (T1/T2):</u> - Subjects with BMI_{T0} < 25 (NW): m non-dieters (n 1551): 9%/29 % m dieters (n 81): 16%/41 % f non-dieters (= 1754): 4%/21 % f dieters (n 392): 6%/25 % - Subjects with BMI_{T0} ≥ 25 (OW): m non-dieters (n 180): 8%/28 % m dieters (n 61): 7%/30 % f non-dieters (n 57): 9%/33 % f dieters (n 83): 12%/27 % → At T1, / risk of major WG in NW dieters' men but not in OW dieters' men → At T1, trend for / risk of major WG in dieters' women (NW and OW) Pairwise analyses of twins on BMI: Dieters > non-dieters (at T0, T1 and T2) Predictors of weight changes: None of BMI_{T0} or parameters evaluated from questionnaires (Restraint Scale, TFEQ and DEBQ) predict weight changes.</p>
Lowe <i>et al.</i> (2006)	<p><u>BW suppression (kg):</u> - Low WS (n 34): -0.77 ± 0.69 - High WS (n 35): -4.68 ± 3.65</p>	<p>BMI at T0: dieters = non-dieters (Δ = 0.9 kg/m²) <u>BW or ΔBW (v. T0) (kg) (T0/T1/T2/T3):</u> - In function of dieting status: Total groups: NR/+0.91/+1.90/+2.08 Dieters: - Current dieters (n 7): 61.4/NR/66/65.1 (+5.0) - Past dieters (n 21): 61.4/NR/62.9/63.9 (+2.5) Non-dieters: 57.4/NR/58.9/58.9 (+1.6) - In function of BW suppression status: Low WS: 59.1/NR/60.5/60.3 (+1.20) High WS: 59.1/NR/61.4/62.1 (+2.97) Time effect (P < 0.01), dieting status x time effect (P < 0.05), BW suppression effect (P < 0.01) on WG (^{NAS} for <i>post hoc</i>) <u>ΔBW (ΔT0–T3) (kg):</u> Low WS/non-dieters: +1.3 ± 0.7 Low WS/dieters: +1.5 ± 0.7 High WS/non-dieters: +2.1 ± 0.5 High WS/dieters: +4.5 ± 0.7 → High WS/dieters > other groups (trend)</p>	

Table 3. (Continued)

Reference	Food intake, dietary and WL	Main results on BW and/or body composition	Additional results
Palascha <i>et al.</i> (2015)	<u>Currents dieters (% of sample):</u> 34 % (n 82)	<u>Weight regain (4 kg or more) after WL:</u> Yes = ' Weight regainers ' (n 55, 23%) No = ' Weight maintainers ' (n 45, 19%) (No WL for the other subjects) → Positive correlation of dieting with weight regain, restraint eating, BMI and dichotomous thinking regarding foods/dieting → Positive correlation of weight regain with restraint eating, BMI and dichotomous thinking regarding foods/dieting → No correlation of dieting and weight regain with general dichotomous thinking	<u>Eating behaviours:</u> → Positive correlation of restraint eating with BMI and dichotomous thinking (general personality and regarding food/dieting) → Positive correlation between BMI and dichotomous thinking regarding foods/dieting → Positive correlation between dichotomous thinking regarding general personality and dichotomous thinking regarding foods/dieting <u>Restraint eating (score):</u> weight regainers > weight maintainers <u>Dichotomous thinking regarding foods/dieting (score):</u> weight regainers > weight maintainers; dieters > non-dieters
Pietiläinen <i>et al.</i> (2012)	<u>Intentional WL ≥ 5 kg (% of sample):</u> m: 76 % never, 13 % once, 9 % at 2–4 times, 2 % at ≥ 5 times f: 62 % never, 23 % once, 13 % at 2–4 times, 2 % at ≥ 5 times → Higher BMI at 16 years, smoked daily, skipped breakfast and having a father in blue collar social class = ↗ risk having ≥1 intentional WL.	<u>BMI (kg/m²) in function of number of intentional WL (T0/T1):</u> m: - 0 WL: 21.4/23.2 - 1 WL: 22.1/24.7 - 2–4 WL: 22.5/25.0 - ≥ 5WL: 22.8/25.8 Effect of number of intentional WL (<i>P</i> < 0.001) (^{NAS} for <i>post hoc</i>) f: - 0 WL: 20.1/21.3 - 1 WL: 20.7/22.0 - 2–4 WL: 21.1/22.6 - ≥ 5 WL: 21.1/23.2 Effect of number of intentional WL (<i>P</i> < 0.001) (^{NAS} for <i>post hoc</i>) → The risk of becoming OW at T1 in the initially NW participants was proportional to the intentional WL frequency	→ Higher BMI at 16 years = ↗ risk of OW at T1 → In females , low PAEE at T0, father's low socio-economic status and father's OW = ↗ risk of OW at T1 → WG in males > WG in females → WG in passive females > WG in active females → Parental BMIs were higher for subjects with the history of WL than subjects without history of WL <u>Pairwise analyses of twins on BMI (kg/m²):</u> In monozygotic twins, BMI at T1 (but not at 16 years and T0) is higher in twins with history of WL (<i>P</i> < 0.05) = dieting effect on WG In dizygotic twins, BMI is always higher in twins with history of WL (16 years, T0, T1) (<i>P</i> < 0.001) = genetic predisposition to higher BMI N/A
Sares-Jäske <i>et al.</i> (2019)	N/A	<u>ΔBMI (kg/m²) (ΔT0–T1):</u> - In dieters: NW (n 191): 1.41 ± 2.42† OW (n 409): 1.17 ± 2.52 With obesity (n 313): 0.54 ± 3.14 - In non-dieters: NW (n 934): 0.76 ± 1.81† OW (n 707): 0.81 ± 2.12 With obesity (n 231): 0.69 ± 3.10 Dieting attempts x BMI interaction (<i>P</i> < 0.01) <u>ΔWaist circumference (cm) (ΔT0–T1):</u> - In dieters: NW: 4.12 ± 8.23 OW: 3.47 ± 8.18 With obesity: 1.65 ± 8.78 - In non-dieters: NW: 2.11 ± 6.18 OW: 2.58 ± 7.08 With obesity: 2.48 ± 8.76 Dieting attempts x initial BMI interaction (<i>P</i> < 0.01) (^{NAS} for <i>post hoc</i>) No interaction effect of previous weight changes at T0 (WL, WG or weight maintenance) x initial BMI on BMI change (ΔT0–T1).	

Dieting in normal-weight individual

Table 3. (Continued)

Reference	Food intake, dietary and WL	Main results on BW and/or body composition	Additional results
van Strien <i>et al.</i> (2014)	<p>Higher WL within 1 month (kg)‡:</p> <p>m non-dieters: 1.26 ± 0.72</p> <p>m dieters: 1.63 ± 0.74</p> <p>f non-dieters: 1.26 ± 0.61*</p> <p>f dieters: 1.57 ± 0.68*</p> <p>Higher BW in life (kg)‡:</p> <p>m non-dieters: 80.78 ± 10.28</p> <p>m dieters: 83.13 ± 13.52</p> <p>f non-dieters: 69.05 ± 9.43**</p> <p>f dieters: 75.14 ± 13.09**</p>	<p>BW (kg)‡:</p> <p>m non-dieters: 75.69 ± 7.90</p> <p>m dieters: 73.38 ± 7.48</p> <p>f non-dieters: 63.34 ± 6.88</p> <p>f dieters: 65.33 ± 6.94</p> <p>Higher WG in a week (kg)‡:</p> <p>m non-dieters: 1.67 ± 0.98</p> <p>m dieters: 2.00 ± 1.07</p> <p>f non-dieters: 1.71 ± 0.99**</p> <p>f dieters: 2.43 ± 1.21**</p>	<p>Feelings of guilt after overeating‡:</p> <p>Non-dieters < dieters</p>
van Wye <i>et al.</i> (2012)	<p>Dieting frequency (% of sample):</p> <p>WC: (35 % sometimes, 33 % often and 14 % always)*</p> <p>NC: (34 % sometimes, 16 % often and 7 % always)*</p>	<p>BW at T0 (kg); height (cm); FM(%); ΔWG(kg) (ΔT0–T1); estimated WG over 10 years (kg/year):</p> <p>WC: 62.1 ± 8.5 kg***; 163.3 ± 6.1 cm*; 25.7 ± 6.3 %; +2.4 ± 5.5****; +0.5 kg/year****</p> <p>NC: 58.7 ± 6.6 kg***; 165.6 ± 5.6 cm*; 24.9 ± 6.5 %; +0.7 ± 4.0****; +0.25 kg/year****</p> <p>→ ↗ aerobic capacity at T0 = ↘ estimated WG</p>	<p>Others:</p> <p>Marital status, smoking status, history of chronic disease, tension and anxiety: WC = NC</p>

WL, weight loss; BW, body weight; HF, high body-fat group; LF, low-body-fat group; REE, resting energy expenditure; FM, fat mass; EAT-26, 26-item Eating Attitudes Test; TEE, total energy expenditure; OGTT, oral glucose tolerance test; ; FFA, fat free acids; NAS, no apparent statistical test; CHO, carbohydrates; WG, weight gain; m: male; f, female; OW, overweight; PA, physical activity; NW, normal weight; WS, weight suppression; NR, not reported; TFEQ, Three-Factors Eating Questionnaire; DEBQ, Dutch Eating Behavior Questionnaire; IWL: intentional weight loss; PAEE, physical activity energy expenditure; WC, weight-cyclers; NC, non-cyclers.

Results are expressed in mean and standard deviation.

* $P < 0.05$.

** $P < 0.01$.

*** $P < 0.001$.

**** $P < 0.1$ (trend).

† Significant but P -value not reported, dieters v. non-dieters or HF v. LF or WC v. NC.

‡ Statistical performed from raw data (t tests).



Fig. 2. Individual and collective quality assessment of the studies included in the systematic review.

Minnesota cohort was divided into four groups with an imposed recovery diet whose energy values varied from 9.95 MJ/d (2377 kcal/d) to 14.19 MJ/d (3389 kcal/d)⁽¹⁴⁾. In the other studies, diet interventions were immediately followed by a period of *ad libitum* energy intake. One study repeated, in the same participants, two 30-d energy-restricted dietary periods, separated by a free-living period of 14 d⁽³⁸⁾. The ten remaining publications of the systematic review were observational studies, including two cross-sectional^(41,42), and eight longitudinal studies that examined weight changes in the long term (8 months to 15 years) in participants representing the overall general population, with two to five measurement time points^(24–27,32,33,35,36) (Table 2).

Characteristics of the participants

All the studies were performed in NW healthy individuals with a mean BMI between 19.5⁽⁴¹⁾ and 24.3 kg/m²⁽²⁵⁾. Among the eight interventional studies, three presented analyses using the same young male population (Minnesota study cohort, *n* 32, 25 ± 4 years)^(13–15). Three other studies enrolled only (or near, *n* 17 males and *n* 1 female for one study⁽⁴⁰⁾) males^(34,37,40), one study was performed in females⁽³⁸⁾, and the last interventional study was performed in both male and female subjects⁽³⁹⁾. The majority of the observational studies involved the sampling from the general population, aged 16 years (but results extracted from 18 years)⁽²⁷⁾ to 54 years⁽²⁶⁾ at baseline, including large cohort

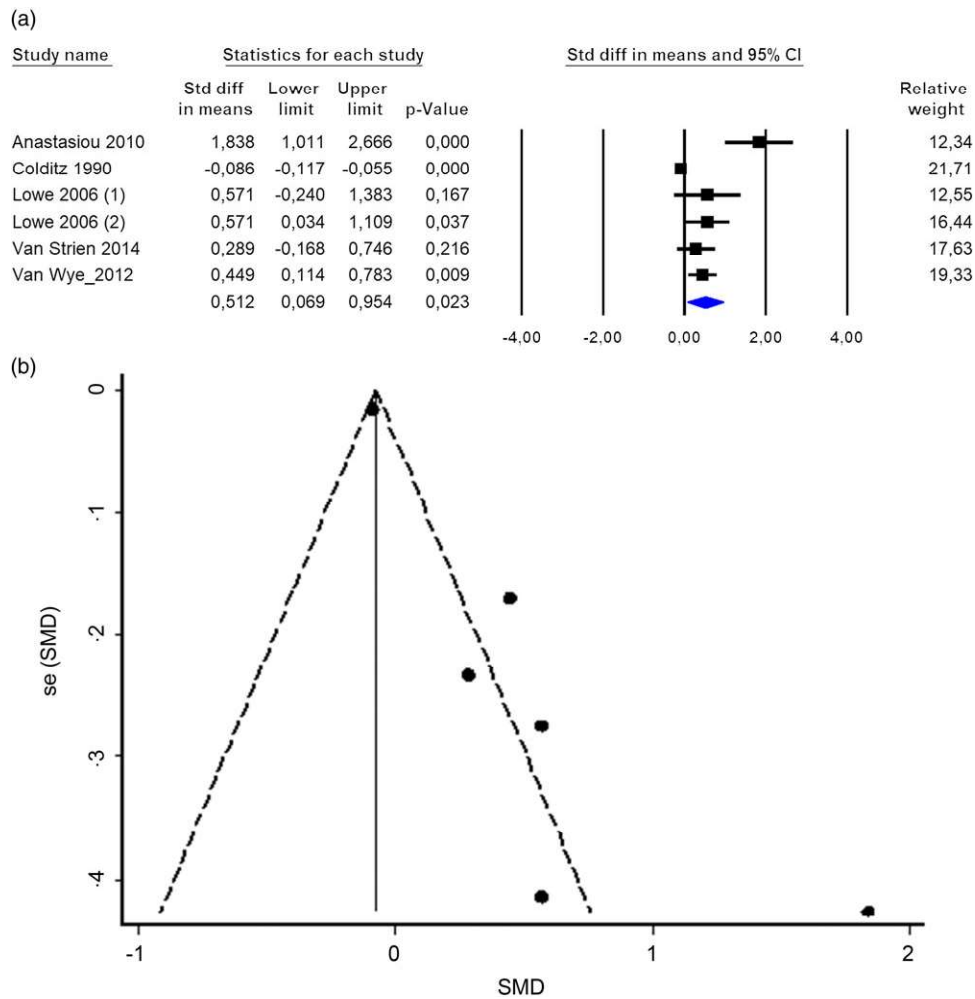


Fig. 3. Body weight comparison between dieters and non-dieters. (a) Forest plot of the meta-analysis. Data were obtained from observational studies and are expressed in standardised mean difference and their 95%CI (lower and upper limits). (b) Funnel plot from the Egger's test. SMD, standardised mean difference.

studies such as the Finnish Twin cohort^(25,27,33) and the Nurses' Health Study cohort⁽²⁶⁾. Three observational studies were performed in women only^(24,26,41), and only female participants were selected in one study since the males were overweight at baseline (BMI ≥ 25 kg/m²)⁽³⁶⁾. In addition, one study selected two specific groups of women in function of their FM: the 'high-body-fat' group having a FM $> 30\%$ and the 'low-body-fat' group having a FM $< 30\%$ ⁽⁴¹⁾. The remaining observational studies compared groups according to their dieting frequency^(24,25,35) or their weight changes^(26,33,36), resulting in groups of 'dieters' and 'non-dieters', or 'weight-cyclers' and 'non-cyclers'. For the study from van Strien *et al.* (2014)⁽³²⁾, NW dieter and non-dieter groups were identified based on the raw data that were available. Participants were defined as 'dieters' when they self-reported dieting 'sometimes', 'often', or 'always', and as 'non-dieters' when they reported having 'never' or 'rarely' done. Due to the low number of participants and the dropout rate during the long-term follow-up in the dieter groups (50% of dropouts in males and 38% in females), we extracted data at T0 only (Table 2).

Parameters assessed and methodological approaches

BW and body composition were assessed in all the interventional studies before WL ('pre-WL'), immediately after the WL phase ('WL'), and after a recovery diet period, termed 'weight (re)gain' ('WG') (except one study which assessed body composition only at pre-WL and WL⁽³⁷⁾). FM and FFM were measured by hydrodensitometry^(13-15,39), plethysmography⁽³⁸⁾, doubly labelled water^(34,37), or bioimpedance⁽⁴⁰⁾. Resting energy expenditure (REE) was evaluated by indirect calorimetry in six of the eight interventional studies^(13-15,34,37,38). Three studies analysed the *ad libitum* food intake during the recovery period^(13,34,37). In addition, one interventional and two observational studies performed biochemical analyses (*e.g.* total cholesterol, insulin, and thyroid hormones)^(35,38,41) (Tables 1 and 2). Over half of the observational studies essentially used questionnaire measurements, with self-reported BW, height, and weight fluctuations^(25-27,32,33,42). In addition, body composition was assessed in only one study by dual-energy X-ray absorptiometry⁽⁴¹⁾, and waist circumference was obtained in three

studies^(33,35,41). Dieting status and food intake were measured by different techniques: 24-h or 1-week self-reported food record^(26,41), 25-item Weight Cycling Questionnaire⁽⁴¹⁾, FFQ^(26,33,35), Restraint Scale^(24,32), or self-reported dichotomous questions/no validated questionnaires^(25,27,33,35,36,42). In longitudinal studies, dieting status was evaluated once during the follow-up period, essentially at baseline (T0)^(24,25,33,35,36), but also at the end of study⁽²⁷⁾ (Table 2). Van Strien and collaborators⁽³²⁾ measured it at each time point (but data were only extracted at T0 as explained above). One study did not assess the dieting status of subjects but measured food intake in the middle of the longitudinal follow-up⁽²⁶⁾. Finally, several observational studies conducted energy expenditure assessments, including total energy expenditure and REE in one study⁽⁴¹⁾, and self-reported physical activity energy expenditure in six studies^(25,27,32,33,35,41). Finally, aerobic capacity was evaluated in two observational studies by a maximal or submaximal cardiorespiratory test^(36,41).

Main results from the interventional studies systematically reviewed

WL interventions resulted in a significant decrease of BW in all studies included^(13–15,34,37–40) (Table 1). FM (% and/or kg) and FFM (kg) significantly decreased ($P < 0.001$) in two cohorts after 30 d, 12 weeks, and 24 weeks of semi-starvation^(13–15,38), with a reduction of REE also observed^(13,38). In the publication of Heyman *et al.* (1992), a decrease in absolute and relative (to FFM) REE was highlighted during and after WL ($P < 0.01$)⁽³⁷⁾. In the analyses of Dulloo and collaborators, most of the subjects of the Minnesota study did not regain their initial BW nor FM (kg), and none had regained FFM, after 12 weeks of imposed recovery diet^(13–15). However, following a subsequent 8 weeks of *ad libitum* energy intake, BW and FM (kg and %), but not FFM, were increased to higher values than those at baseline⁽¹⁴⁾. In one study⁽⁴⁰⁾, BW was not recovered after 40 weeks of a free-living period, but participants were encouraged to maintain the low-fat diet during this period. In three other studies, BW was restored as early as day 10 of *ad libitum* food intake^(34,37,38), the regain being showed more rapid than the WL ($+257 \pm 120$ g/d *v.* -97 ± 79 g/d, $P < 0.01$) in one publication⁽³⁷⁾. In Moriguti *et al.*'s cohort, BW was restored after 6 weeks, and NW subjects regained significantly more than the group of overweight subjects⁽³⁹⁾. In Kajioaka's study, after the first recovery period (14 d), BW overshoot baseline value while FM did not change (Table 1). Yet, after the second dieting phase and 106 d of free-living, BW and FM were similar to pre-WL values⁽³⁸⁾. In addition, hyperphagia was observed in three studies relative to pre-WL energy intake^(13,34,37). Finally, after several weeks of recovery diet (12 to 15 weeks), REE remained at lower values than at baseline^(13,38). Results of biochemical parameters assessed in one study are detailed in Table 1. Finally, in Kajioaka's study, blood pressure (both systolic and diastolic) was significantly reduced after the second WL phase but was significantly elevated compared with pre-WL after 15 weeks of free-living conditions⁽³⁸⁾.

Main results from the observational studies systematically reviewed and meta-analysed

Studies conducted in Greece and the USA observed that high-body-fat and weight-cycler groups had significantly higher BW and BMI and dieted more often compared with low-body-fat⁽⁴¹⁾ and non-cycler⁽³⁶⁾ groups, respectively. In another such study conducted in Finland, BMI at baseline was higher ($P < 0.001$) in male and female dieters compared with non-dieters⁽²⁵⁾, while a further study showed no difference in BMI and BW between these groups⁽³²⁾ (Table 3). Forty per cent of the studies reviewed observed a significant increase, or increasing trend, in BMI or BW in NW individuals engaging in diet/WL compared with those who did not diet and/or lose weight^(25,32,35,36), while two others studies showed a positive association between WG and dieting^(33,42). Moreover, major WG was associated with a lower initial BW or BMI^(25,27,33,35), irregular eating⁽³³⁾, dieting^(24,25,27,33,42), smoking⁽³³⁾, and restrained eating⁽⁴²⁾. Finally, five studies were selected for inclusion in the meta-analysis according to our selection criteria^(24,26,32,36,41). In the study of Anastasiou and collaborators, the high-body-fat group was considered analogous to 'dieters' and low-body-fat group to 'non-dieters', given that the high-body-fat group had a higher number of WL achieved per year and a higher total energy expenditure, while it had a reduced daily food intake and a higher score for the 26-item Eating Attitudes Test dieting subscale compared with the low-body-fat group⁽⁴¹⁾. For another study⁽²⁶⁾, we defined the 'dieters' as those who consumed less than 5.0 MJ/d (1205 kcal/d) (similar value to a semi-starvation), while 'non-dieters' were those who ingested more than 7.7 MJ/d (1844 kcal/d). Overall, the result of the meta-analysis showed that dieters had, on average, a higher BW compared with non-dieters (standardised mean difference: 0.512 [95% CI: 0.069, 0.954]; $P = 0.023$), as illustrated in Fig. 3(a). The standard differences in means ranged from -0.086 to 1.838 ($n = 5$), and there was a high heterogeneity between studies ($I^2 = 87.6\%$; $Q = 40.42$; $df = 5$; $P < 0.001$). The results of the Egger's test highlighted a publication bias (2.813 [95% CI: 1.192, 4.434]; $P = 0.009$), and the funnel plot is illustrated in Fig. 3(b).

Discussion

While rising rates of overweight and obesity have led to an increasing pre-occupation around weight control and WL in the recent years⁽⁴³⁾, dieting also became quite common among NW individuals^(4–6,44). Social pressure relative to thinness, particularly among women, can drive them to lose weight, despite the absence of medical necessity contrary to people suffering from overweight or obesity^(7–9). Although frequent, the effects of WL in healthy NW individuals remain poorly investigated. While a sustainable energetic restriction seemed to show some beneficial effects in NW populations^(18–20), the high availability of fatty, sweet and ultra-processed food in the occidental diet leads to overconsumption and it became difficult to maintain low-energy intake on the long term^(21–23). Consequently, the probability of weight regain after a WL induced by diet is high, and few



studies and reviews suggested negative impacts of dieting, in particular an increased risk factor for later obesity^(4,12,27). In this context, the present work undertook a systematic analysis of the available studies questioning diet-induced WL and subsequent or long-term BW changes in healthy NW individuals. After a detailed and strict selection process, eighteen publications met the inclusion criteria for review. Importantly, our systematic approach clearly highlighted a high level of methodological heterogeneity between studies, which was certainly the first and maybe main result of the present work. Indeed, while eight of the included papers were interventional, ten were observational; six of the eight interventional studies being conducted among males only (or near, 94.4% of men in one study⁽⁴⁰⁾)^(13–15,34,37,40), and four of the ten observational studies involved females only^(24,26,36,41). As detailed in Table 1, the duration, the nature of diets (*e.g.* proportion of macronutrients and magnitude of energy deficit), and even the methods used to assess WL itself were highly heterogeneous, leading to a complex comparison of study results.

Observational studies

In observational studies, the dieting status of the participants was assessed using different self-reported methods, which considerably limits the reliability of results. In addition, information about the practice of dieting or food intake was available at only one time point for 88% of the longitudinal studies, and thus there was no indication of the persistence or interruption of the diet during the follow-up (Table 2). Importantly, the term 'diet' was poorly defined in all the observational studies, and the characteristics to determine the dieting status of subjects were various. While we defined diet as restricting energy intake or certain kinds of food in order to lose weight, dieting can be also described as maintaining, gaining or losing weight by the regulation of food intake^(4,44). Therefore, if 'dieting' includes the control of food intake to maintain a stable weight, it appears crucial to 'diet' in an obesogenic environment to prevent WG, without any WL induced by restricted food. Regarding the lack of consensus on the definition of dieting and the subjectivity and heterogeneity of methods to assess this status, the results have to be interpreted with caution. Finally, concerning the BW assessment, data were self-reported in 60% of the included observational studies, with only two measuring body composition^(36,41). While there was a large heterogeneity in these observational studies, all of them seem to show a negative effect of dieting on BW, body composition and/or long-term BW changes. Despite the absence of statistical analysis, Colditz and collaborators observed that individuals who previously lost more than 5 kg gained about fourtimes as much weight over an 8-year period than those with lower weight variations (≤ 3 kg)⁽²⁶⁾. Moreover, 80% of these observational studies showed a relationship between dieting and long-term weight change, with a major risk of WG related to diet^(24,25,27,32,33,35,36,42). Finally, three studies found a significantly higher BMI or BW in dieters than in non-dieters^(25,36,41), that was confirmed by the results of our meta-analysis (Fig. 3). However, this result is questionable: is higher BW in dieters the cause or the consequence of dieting? Indeed, as suggested by Heberbrand & Hinney⁽⁴⁵⁾, initial BW and the tendency to

easily gain weight are in part imputable to genetics as a risk factor for obesity. Consequently, people with higher initial BW, while still being within the NW range, are more likely to engage in diet compared with those with a lower BW, all the more if dieting can be defined as control of food intake to maintain weight or limit WG without necessary WL (in link with the definition of diet discussed above). Although our systematic and meta-analytic approaches both suggest that regular NW dieters might be at risk for later extra weight regain compared with non-dieters, it remains to be clearly determined (using a controlled interventional study design) whether WL *per se* is the cause of this subsequent higher BW. Importantly, Pietiläinen and collaborators⁽²⁷⁾ questioned the role of genetics in long-term WG in twins. They suggested an important effect of genetic predisposition illustrating by a higher BW in dizygotic twins trying to lose weight, but they also highlighted an effect of dieting *per se*, with larger long-term WG in dieters compared with non-dieters in monozygotic twin pairs⁽²⁷⁾. However, objective measures of WL and weight regain are lacking in these observational studies, and interventional studies are therefore necessary to better understand the consequences of dieting on later weight changes.

Interventional studies

The classic Minnesota study remains, to date, the only energy restriction study to show a higher BW and FM after recovering from 24 weeks of drastic (semi-starvation) WL relative to baseline in NW healthy subjects⁽¹⁴⁾. However, weight recovery after 8 weeks of energy deficit (and about 14% WL) induced by intense physical activity in young men undergoing the US Army Ranger training has also been reported to be accompanied by higher BW and FM values than at baseline; reviewed in reference⁽¹⁴⁾. In their work on dieting and later WG, Kajioaka *et al.*⁽³⁸⁾ only observed a lower FFM in NW individuals, without any change in BW or FM, after two repeated cycles of WL and weight regain. Importantly, both this study and the Minnesota study observed a lower REE after WL and weight regain compared with pre-WL^(13,38), highlighting an adaptive reduction of thermogenesis. This phenomenon is well documented in the literature in response to WL both in NW people^(46–49) and people with obesity^(46,50–52). While a decrease in FM and FFM could partly explain the decrease in REE, cellular adaptations are made by the organism to promote energy conservation. In fact, a reduction of REE relative to FFM was observed after WL, both in male⁽³⁷⁾ and female⁽⁴⁹⁾ NW subjects. Although some studies reported that this 'thrifty metabolism' in REE seems to be attenuated or to disappear after a period of weight maintenance in individuals with obesity^(47,51), there is evidence that adaptive thermogenesis in the compartments of REE and/or in non-REE may persist for several months to a year during the weight-reduced state^(53–57). Importantly, the suppression of adaptive thermogenesis has been shown to persist in NW individuals, with a reduction of 15 to 20% in REE over 15 weeks after weight recovery^(13,38). In addition, Kajioaka *et al.*⁽³⁸⁾ observed a decrease of triiodothyronine and thyroxine blood concentrations after WL intervention and recovery, both being implicated in energy





metabolism and adaptive thermogenesis⁽⁵⁸⁾. Semi-starvation and refeeding experimentations in rats have also highlighted cellular adaptations leading to an energy economy in skeletal muscles that persists during refeeding, including decreased muscle thyroid hormone levels⁽⁵⁹⁾.

Beyond compensatory adaptations in energy expenditure, an increase in energy intake above baseline has been observed during weight recovery in NW individuals, illustrating post-WL hyperphagia^(14,34,37). This increase in energy intake was shown in NW people after acute energy deficits induced by diet⁽⁶⁰⁾ and in subjects with overweight or obesity after dietary WL intervention⁽⁶¹⁾. Overall, hyperphagia and adaptive thermogenesis are compensatory adaptations that aim to resist WL during energy deficit and to facilitate weight regain. However, these modifications seem to persist after weight regain in NW individuals^(14,34,37) and could explain the increase in BW above baseline values during post-dieting recovery. Indeed, in the Minnesota study, weight recovery was driven by persistent slowed metabolic rate and concomitant hyperphagia, resulting in more rapid restoration of FM than FFM. The hyperphagic state persisted beyond complete recovery of FM, until FFM has returned to baseline values^(14,15,62), thereby resulting in an increase in FM beyond pre-WL values (*i.e.* fat overshooting)^(14,16), and consequently a higher BW than baseline.

Importance of body weight status

In the Minnesota study, initial FM (%) was negatively associated with individuals' *P*-ratio, an index of body energy partitioning⁽¹⁵⁾, suggesting that leaner subjects are more susceptible to mobilise energy from protein (FFM) during WL and to experience a FM rebound during weight regain^(12,14). The recent narrative review of Magkos (2022) supports this major loss of lean tissue in response to diet in NW people compared with subjects with obesity⁽¹⁷⁾. In addition, Roberts *et al.* observed a negative correlation between initial FM and hyperphagia during recovery⁽³⁴⁾, corroborating the hypothesis that leaner subjects were at higher risk of weight regain. Besides the dieting effect, several other studies of the systematic review highlighted the potential influence of weight status on BW evolution, whereby NW dieters are at higher risk for long-term WG than dieters suffering from overweight or obesity^(25,27,35,39). According to the theory of fat overshooting, habitual dieters, and specifically NW individuals, could be subject to catch-up fat resulting in higher BW than pre-WL^(12,15). Consequently, if NW dieters try again to lose weight by repeating WL and weight regains (*i.e.* weight cycling), the cumulative amount of fat overshoot over several weight cycles could ultimately result in obesity, as recently illustrated using a mathematical model of weight cycling that integrates the relationship between post-dieting fat overshooting with initial adiposity⁽⁶³⁾. Independently of the gain in BW, weight cycling induced by diet seems to be associated with increased cardiometabolic risk, particularly in NW people⁽⁴⁾, and even in athletes despite their high physical activity levels^(64,65). In that context, it appears important to prevent these potential risks associated with diet and weight cycling in initially healthy NW people.

Which role for physical activity?

Although physical activity and/or fitness levels were assessed in 70 % of the included observational studies^(25,27,32,33,35,36,41), there was limited information about the relationship between WG, diet, and physical activity level. Nevertheless, physical activity has been suggested to limit the compensatory adaptations in response to energy deficits induced by diet in NW people⁽⁶⁰⁾. Physical activity may therefore serve as a preventive strategy against fat overshooting thanks to the maintenance of FFM (or in minimising its loss) during WL, as demonstrated in people with obesity^(66,67) and suggested in athletes⁽⁶⁴⁾. However, this potential protector effect may depend on the degree of energy deficit and nature of physical activity performed. Indeed, while participants of the Minnesota study were asked to walk 35.4 km each week⁽⁶²⁾, they were also confronted with a semi-starvation diet, which might have surpassed the preventive effect of physical activity on FFM and other compensatory mechanisms.

Limitations

Several limitations must be considered in the present study. First, we use three important and relevant databases (*i.e.* PubMed-Medline, Embase, and Google Scholar) for our literature search strategy, but missing to include other databases, such as Web of Sciences or Scopus, might represent an important limitation of the present work that needs to be considered. Further, the systematic approach revealed an important heterogeneity between studies in terms of methodology, which somewhat restrict our analyses and conclusions. Then, in the observational studies, dieting status was not clearly defined by authors and not ascertained by objective measurements of WL and food intake in individuals reporting to diet, and our results must therefore be considered with precaution. Concerning the interventional studies, sample sizes remain modest and the majority relied on very-low energetic diets (semi-starvation). However, Julia and collaborators reported in the general population a high prevalence of consumption of non-individualised commercial diets (and low prevalence of diets prescribed by professionals), which are generally low- to very-low-energy diets⁽⁶⁾. Finally, the interventional studies were not controlled by a group of NW subjects without WL intervention. These limitations highlight the need to conduct studies to standardise methodological approaches with investigator-verified, objective measurements of BW and body composition throughout WL – WG cycles in NW individuals.

Conclusion

A significant proportion of NW individuals are engaged in dieting to control their weight, notably because of body image distortion and social pressure. The present systematic review seems to indicate that both interventional and observational studies, separately, suggest potential negative effects of dieting on BW and body composition in this population. Despite the observed high methodological heterogeneity and the significant publication bias, the meta-analysis of observational

studies underlines a higher BW in dieters than in non-dieters. However, the results do not allow to confirm that higher BW and higher WG observed in dieters is the consequence or the origin of the practice of dieting. Similarly, the present systematic analysis of the included interventional studies suggests that negative energy balance induced by dieting generates compensatory adaptations, which may persist during refeeding and even after BW recovery in NW people, but leading to increased FM and BW relative to pre-WL only in one study. Importantly, the present systematic and meta-analytic approaches clearly add to the existing literature that the available evidences suffer from high methodological heterogeneity (both for interventional and observational studies), deeply limiting the formulation of strong conclusions and calling for further well-designed studies. While dieting could be a controversial risk factor for later obesity in NW individuals, there is a clear need to better understand the physiological adaptations occurring during WL and weight regain in this population *via* randomised controlled interventional studies.

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ANNEXE 2




Reprise de poids, composition corporelle et réponses métaboliques à la perte de poids chez les athlètes habitués au « *weight cycling* » : Revue systématique et méta-analyses

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REVIEW

Weight regain, body composition, and metabolic responses to weight loss in weight cycling athletes: A systematic review and meta-analyses

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Abstract

Depending on the nature of their sports, athletes may be engaged in successive weight loss (WL) and regain, conducing to “weight cycling.” The aims of this paper were to systematically (and meta-analytically when possible) analyze the post-WL recovery of (i) body weight and (ii) fat mass; fat-free mass; and performance and metabolic responses in weight cycling athletes (18–55 years old, body mass index < 30 kg.m⁻²). MEDLINE, Embase, and SPORTDiscus databases were explored. The quality and risk of bias of the 74 included studies were assessed using the quality assessment tool for quantitative studies. Thirty-two studies were eligible for meta-analyses. Whatever the type of sports or methods used to lose weight, post-WL body weight does not seem affected compared with pre-WL. While similar results are observed for fat-free mass, strength sports athletes (also having longer WL and regain periods) do not seem to fully recover their initial fat mass (ES: –0.39, 95% CI: [–0.77; –0.00], $p = 0.048$, $I^2 = 0.0\%$). Although the methods used by athletes to achieve WL might prevent them from a potential post-WL fat overshooting, further studies are needed to better understand WL episodes consequences on athletes' performance as well as short- and long-term physical, metabolic, and mental health.

KEYWORDS

athlete, body composition, fat overshooting, weight cycling

1 | INTRODUCTION

Although most of the time studied among individuals with overweight and/or obesity who seek effective and sustainable long-term weight loss (WL) strategies, athletes also experience regular and quite often rapid body weight (BW) variations.¹ Indeed, depending on their disciplines, athletes voluntarily engage in frequent WL for aesthetic,

categorical (weight classes), and/or performance reasons.^{2–4} Successive WL and weight regain (WG) in male and female athletes, called “weight cycling” (WC), is most frequently observed in weight-category sports such as combat sports and may begin during adolescence.^{5–10}

Many studies have examined the methods and consequences of short-, medium-, and long-term WL and WG in athletes and in general

conclude that although WL is a common practice, its magnitude, frequency, duration, and the strategies used appear highly variable depending on the considered sport.^{11–16} Increased physical activity combined with food and liquid restriction is commonly used in athletes to induce a negative energy balance both increasing energy expenditure and decreasing energy intake (EI). Depending on the diet method employed during the WL phase (i.e., voluntary restriction of EI to lose weight), a loss of fat mass (FM) as well as fat-free mass (FFM) can be observed in different proportions.^{17–19} However, a continued desire to tightly control BW can lead to the use of extreme methods that may induce negative health consequences, such as malnutrition, hypoglycemia, dehydration, or excessive stimulation of adrenal receptors.^{17,20–23} Furthermore, it has been shown that WL generated by an energy deficit can lead to compensatory responses.^{24–28} Increases in sensations of hunger, palatability of food, and desire to eat after dietary restriction would favor post-diet WG. By stopping the use of such WL methods, athletes can enter a recovery period leading to BW regain.¹⁷

Well studied in the non-athlete population, the WG period following a WL can be accompanied by a recovery of FM and/or FFM in variable proportions and sometimes higher than initial (pre-WL) values.²⁹ In fact, in their seminal publications, Dulloo et al. clearly point out that non-athlete normal-weight dieters tend to regain the weight lost following a very low-calorie diet (semi-starvation), often exceeding original pre-diet values.^{29,30} Adaptive thermogenesis, nutrient deficiency, and hyperphagia during recovery can all contribute to a preferential and accelerated regain in FM (i.e., preferential catch-up fat), thereby resulting in an asymmetry in recovery of body composition with FM recovery reaching completion before FFM is fully recovered.³¹ This deficit in FFM persisting after completion of FM recovery was shown to be associated with persistent hyperphagia until FFM eventually returned to its baseline value,^{29,30} but which was accompanied by concomitant fat deposition; this process of “collateral fat gain”³¹ would underlie the “fat overshooting” phenomenon (i.e., more body fat is regained than was lost). Even if combining such caloric restriction with physical activity may have a valuable effect on energy balance and the preservation of FFM, and would limit the compensatory responses in athletes,³² this phenomenon remains underexplored among athletes.³³

Successive WL and WG, also observed among soldiers,^{34–37} are recognized to alter the athletes' physical performance and metabolism,²³ even if the results remain equivocal regarding the longer-term residual impact. Indeed, while physical, psychological, and metabolic profiles have been restored after WG (back to pre-WL values) by some authors,^{38–42} others have shown that such alterations might persist despite post-diet BW recovery.^{35,37,40,43,44}

Given the plethora of articles on WL and WG in athletes and the diversity of dieting and recovery methods employed by athletes in different sports categories, it seems essential to comprehensively identify and then synthesize the available evidence using systematic and meta-analytic approaches. Therefore, the main objective of this work was to systematically overview the BW evolution during an episode of WL (from pre-WL to WL and WG) in WC athletes (considering the

type of practiced sport and the methods used to achieve WL). Secondly, following a similar systematic approach, we reviewed the effect of such WL episodes on WC athletes' body composition, physical performance, quality of life, and metabolic profile. Meta-analyses were performed comparing pre-WL, WL, and WG data, when possible.

2 | METHODS AND PROCEDURES

2.1 | Protocol and registration

This systematic review has been registered in the International Prospective Register of Systematic Reviews (PROSPERO; registration number: CRD42021281448) and was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.⁴⁵

2.2 | Literature search strategy

An electronic search was conducted using Pubmed/MEDLINE, Embase, and SPORTDiscus databases in April 2021, with searches later updated with recent papers until December 31, 2021. The search included four blocks of terms using the Boolean operators “AND” or “OR” and was adapted for each database. The first theme was “weight cycling.” The second theme was “weight variations” devolved into the following keywords: “weight loss,” “weight gain,” and “diet.” The third theme concerned athletes, with a focus on “sports” and, because of their high physical activity level and their intensive training programs, “military personnel” keywords. The last theme was “recovery” and concerned the body weight evolution following a diet. The detailed search syntax and strategy applied for each database are available in Table S1. Limits were set to include all English-language articles on human studies and published after 1945.

2.3 | Inclusion and exclusion criteria

All observational and interventional studies were considered if they involved healthy male and female WC athletes or soldiers, between 18 and 55 years old, with or without a control (CT) group of non-WC athletes. Due to ongoing physiological maturation processes affecting body weight and composition, studies on adolescents were not considered. To allow for the increased muscle mass of many athletes, athletes with a body mass index (BMI) < 30 kg.m⁻² (i.e., including the “overweight” BMI category) were considered in this review. Studies had to present quantitative and/or qualitative measures of anthropometry and/or body composition data after a WL induced by an energy restriction, with or without additional methods. Included studies were also required to include a post-WL follow-up assessment. Studies were not included if they involved animals, people with obesity, individuals with an injury or illness (e.g., cancer, diabetes), pregnant women, elderly people, children, or adolescents.

2.4 | Study selection and data extraction

Study selection and data extraction were done using the software Excel (Microsoft Corporation, 2018. Microsoft Excel, available at <https://office.microsoft.com/excel>). The search and selection strategies were conducted by four members of the investigation group (S.B., L.P., L.I., and D.T.). Duplicates were removed, and titles and abstracts were screened independently by two reviewers (S.B. and L.P.). Any disagreement between them was discussed and resolved by one or two extra reviewers (L.I. and/or D.T.). The full text of retained studies was further screened according to the eligibility criteria by the two reviewers. Any disagreement was resolved through a discussion between the two reviewers. For each study, the following data were extracted: (i) reference (name of the first author, year of publication), (ii) population characteristics (country, size of the sample, baseline age, BMI, weight and height, and type of sport), (iii) study design (longitudinal or transversal, observational or interventional, controlled or not, retrospective or not), (iv) follow-up duration and time points between each measure (identified according to the “pre-WL,” “WL,” or “WG” periods), (v) interventional protocol if needed, (vi) outcomes and method of assessment, and (xi) research results. Study results were extracted with a focus on the following main conditions: (i) quantitative measurement of weight before and after a diet and after a recovery period post-WL, (ii) weight history and management, (iii) body composition assessment (i.e., FM and FFM), and (iv) other associated factors such as physical condition and performance, quality of life, eating behavior, food intake, energy expenditure, and biological parameters (quantification of blood lipid, glucose, insulin, cholesterol, etc.). A narrative synthesis of the findings from the included studies was performed. If the bodyweight evolution (WL or WG) was mentioned but not given in kilograms, or the weight evolution was mentioned as a relative WL or WG, the corresponding author was contacted to obtain the raw data. Given the specific conditions of their WL, soldiers will only be included in meta-analyses if at least four studies meet the selection criteria.

2.5 | Quality assessment

The quality of the included studies was assessed independently by two reviewers (S.B. and L.P.) using the “Quality assessment tool for quantitative studies” developed by the Effective Public Health Practice Project (EPHPP).^{46,47} This tool is recommended for quality assessment in systematic reviews, including uncontrolled studies. For each study, selection bias, study design, confounders, blinding, data collection method, and withdrawals/dropouts were rated as strong, moderate, or weak. The global methodological quality was rated as weak if there were two or more weak ratings sub-domains, moderate if there was one weak rating, and strong if there were no weak ratings. The results were presented using a traffic light plot to depict the risk of bias for each sub-domain of the scale for each study. A summary bar plot was also used to represent the proportion of information with a given level of bias for each sub-domain quality assessment scale.

Quality data processing was done using the software Excel (Microsoft Corporation, 2018. Microsoft Excel, available at <https://office.microsoft.com/excel>).

2.6 | Statistical analysis

Baseline characteristics were summarized for each study sample and reported as mean and standard deviation (SD) or median and interquartile range and number (%) for continuous and categorical variables, respectively.

2.6.1 | Estimation of the standard deviation of the paired mean difference

The analyses were performed with SD of the paired mean difference between pre-WL (T₀), WL (T₁), and WG (T₂) estimated using the formula: $[SD^2T_0 + SD^2T_i - (2 \times 0.5 \times SDT_0 \times SDT_i)]$ ($i = 1, 2$). Means and SD were compiled when available or were estimated when median and interquartile ranges were reported. When data were presented in graphs, results were estimated using WebPlot-Digitalizer.⁴⁸ If needed, case studies with similar protocols and parameters were pooled as one study by calculating mean and SD.

2.6.2 | Estimation of standardized paired mean differences (Hedge's *g* effect size)

To evaluate the estimate post-diet WG, meta-analyses were performed comparing the mean BW (kg) before the diet (pre-WL), at the end of the WL (WL), and post-diet recovery (WG).

The meta-analyses considered between- and within-study variability. To address the non-independence of data due to study effect, random effects models were preferred to the usual statistical tests to assess the standardized paired mean differences (ES for Hedge's *g* effect size corresponding to post-diet WG) and their 95% confidence intervals. Hedge's *g* effect size was estimated to assess the difference between baseline (pre-WL) and follow-up time points evaluation (WL and WG). Hedge's *g* is considered to be a conservative estimate, which is useful for studies with small sample sizes, and the results may be interpreted as reflecting a small ($g = 0.2-0.5$), medium ($g = 0.5-0.8$), or large effect ($g > 0.8$).

2.6.3 | Heterogeneity

Heterogeneity in the study results was assessed by forest plots, Q Cochran's homogeneity test, tau squared index, and I^2 statistic. More precisely, I^2 is a common metric for measuring the magnitude of between-study heterogeneity and can be interpreted as followed: $I^2 < 25\%$: low; I^2 between 25% and 50%: moderate; and $I^2 > 50\%$: high.⁴⁹

2.6.4 | Publication bias

Publication bias was assessed by funnel plots, confidence intervals, and the Egger regression test as a formal statistical test.

2.6.5 | Subgroup analyses

For subgroups analyses, Δ BW, Δ FM, and Δ FFM between pre-WL, WL, and WG time points were analyzed considering six variables: (i) sex, (ii) diet status, (iii) type of sport, (iv) WL duration, (v) WG duration, and (vi) WL \times WG duration.

2.6.6 | Secondary analyses

Where data were sufficient, meta-analyses of changes in FM (in kilograms and percentage of BW) and FFM (in kilograms) were also performed. Meta-analyses of Δ BW, Δ FM, and Δ FFM based on EI, proteins, lipids, and carbohydrates (CHO) intakes were considered, but insufficient data were available to distinguish categories (e.g., high vs. low EI).

Statistical analyses used Stata software (version 15, StataCorp, College Station, TX, US). The two-sided type I error was fixed at 5%. Because of the potential for type 1 error due to multiple comparisons, findings from analyses of secondary endpoints will be interpreted as exploratory.

3 | RESULTS

3.1 | Search results

The different stages of selection and the reasons for the exclusion of articles were presented in Figure 1. Overall, 74 studies published between 1990 and 2021 were included in this systematic literature review. Five cohorts were studied in 13 different articles, but the data presented in each paper complement each other.^{39–42,50–58} Among the 69 studies that assessed quantitative BW, 37 studies were not included in the meta-analyses considering following criteria in this order: (i) data were missing for pre-WL, WL, and/or WG time point ($N = 20$)^{3,4,40,52,56–71}; (ii) the articles were subgroups of a global cohort described in another article ($N = 5$)^{40,42,50,54,55}; (iii) the sample size was unclear ($N = 1$)⁴⁴; (iv) the calculation of the relative WG was unclear (from pre-WL or WL) ($N = 2$)^{72,73}; (v) the duration between pre-WL and WL time points was unclear (e.g., pre- and mid-season) ($N = 4$)^{74–77}; (vi) SD was missing ($N = 1$)¹⁴; (vii) not enough studies had collected data in soldiers with a very specific ranger training ($N = 3$)^{34–36}; and (viii) five case studies were pooled as two (Morehen et al.⁷⁸ and Kasper et al.⁷⁹; Halliday et al.,¹⁶ Pardue et al.⁸⁰ and Rossow et al.⁸¹), but one case study cannot be pooled with others because of its specific design.⁸² Authors were contacted, but the missing information/data needed to include the studies was not

always obtained. Then, seven studies were included in meta-analyses thanks to raw data sent by the authors, conducting 32 the total number of studies included in the meta-analyses.^{2,11–13,16,38,39,41,43,53,78–81,83–100}

3.2 | Study quality

The quality assessment of the included studies was detailed in Figure 2. Twenty-one studies had a weak global rating,^{4,12–15, 39,44,51,52,57,58,66,83,84,86,90,94,96,98,100,101} 24 studies were evaluated as moderate,^{2,3,11,34,36–38,59,63,65,67–71,74,75,77,92,93,97,99,102} and 29 studies had a strong global rating.^{16,40–43,50,53–56,60–62,64,72,76,78–82,85,87–89, 91,95,103,104} Considering the high number of studies with no CT groups and balanced CT groups if applicable, cofounders were evaluated as the strongest criteria while the lack of blinding was highlighted in almost a third of the studies.

3.3 | Studies and population characteristics and main methodological approaches

Included study designs, methods, and population characteristics were detailed in Table S2. Figure 1 specifically details the designs of the selected studies as well as the type of concerned sports.

3.3.1 | Anthropometry and body composition

BW and weight variations were assessed in 56 studies.^{2,16,34–43,50,53–72, 74–82,85–89,91–93,95,97,101–104} Most of the body composition (at least FM and/or FFM) measurements were conducted using dual-energy X-ray absorptiometry (DXA), which is the most accurate method ($N = 20$).^{16,34–37,39,41,42,50,54–58,77–82} Moreover, 14 used skinfold thickness,^{16,35,39,43,64,71,72,74–77,79,85,86} 6 performed underwater weighing,^{38,40,53,67,87,88} 4 used bioelectrical impedance analysis,^{39,67, 81,82,92,93} 2 used the 4C-model,^{81,82} 2 used ultrasounds,^{55,97} and one used air-displacement plethysmography.⁸⁰

3.3.2 | Weight management

Weight management and history were assessed in 30 articles.^{2–4,11–15, 44,51,52,56–58,62,67,68,74,77,83,84,90,91,94,96,98–101,104} Usual WL methods were recorded using the Rapid Weight Loss Questionnaire (RWLQ) ($N = 15$)^{2,3,11–13,44,83,84,90,91,94,96,98–100} and similar questionnaires ($N = 6$),^{4,14,67,68,74,77} interviews were conducted in seven studies,^{51,52,56–58,70,101} one article initiated a survey,⁶² and one used a specific Military Eating Behavior Scale.¹⁰⁴

The methods used to assess of the other considered outcomes (EI, dietary and eating behaviors, physical activity and performance, hydration status, metabolic profile, and psychometric variables) are presented and detailed in Table S2.

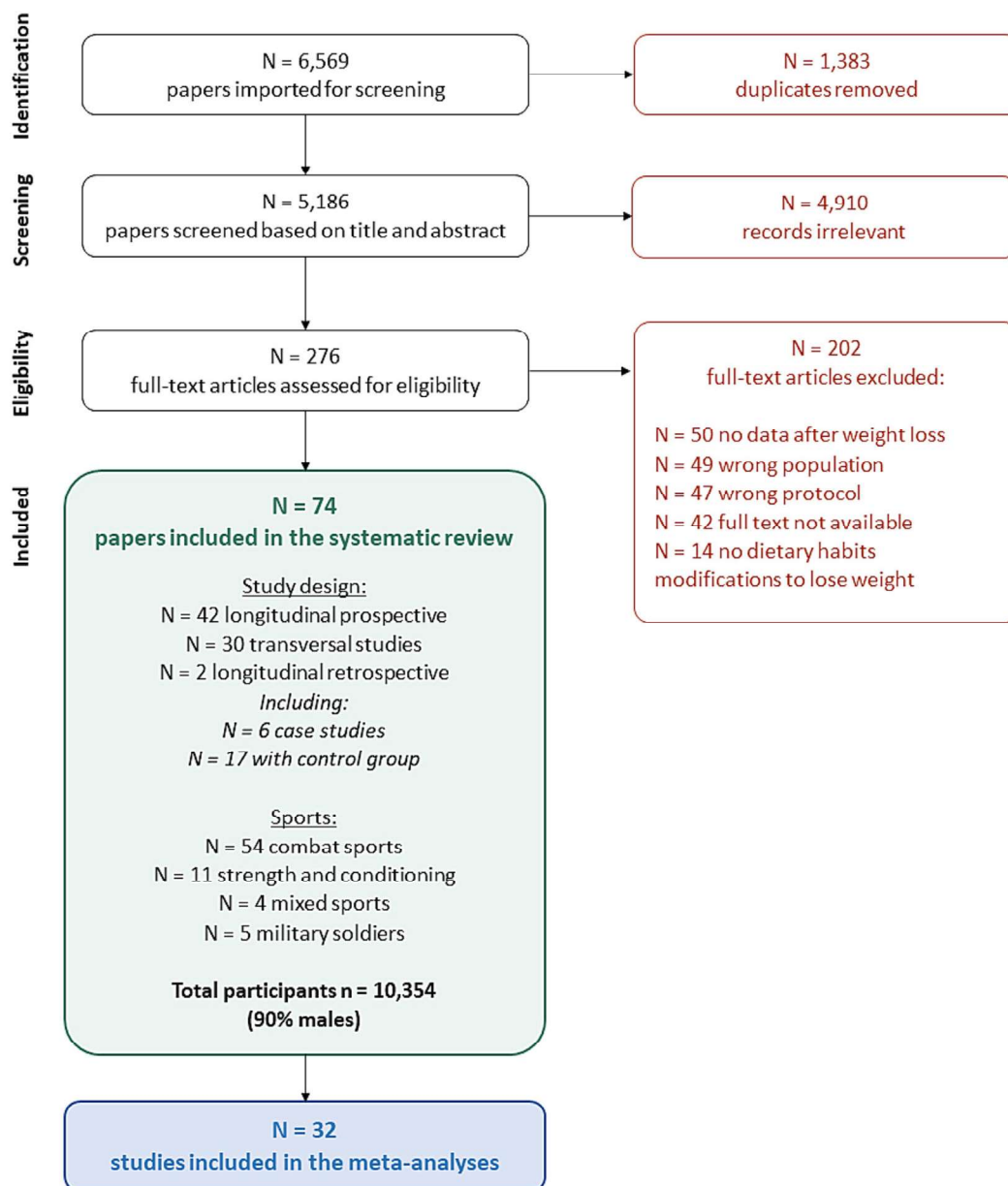


FIGURE 1 Flow chart illustrating the different phases of the search and study selection.

3.4 | Dieting as an athlete: Effect on body weight and body composition. Systematic and meta-analyses of main results

Table S3 details the results of the literature regarding BW, FM, and FFM variations at pre-WL, WL, and WG time points in athletes, considering the WL strategies used and the WG conditions by type of sport and study design. Figure S1 proposes a complete and detailed graphical summary of these results. Forest plots obtained from the meta-analyses comparing pre-WL and WG conditions for BW and for body composition (FFM and FM) are presented in Figures 3 and 4, respectively, considering the WL and WG duration and the type of sport.

For the sake of brevity and given the systematic review of the articles, it does not seem relevant to distinguish the results by design type in the following parts. Therefore, the results will be presented for interventional and non-interventional studies combined for each sport category. For a better consideration of the results, subject-adjusted means were calculated for each parameter by sport category (type of sport) using the following equations: $\bar{x} = \frac{\sum_{i=1}^N \bar{x}_i n_i}{\sum_{i=1}^N n_i}$ (1) and $\sigma = \frac{\sum_{i=1}^N n_i (\bar{x}_i - \bar{x})^2}{\sum_{i=1}^N n_i}$ (2), with \bar{x} the general mean of the considered parameter, σ the associated SD, N the total number of studies considered for this parameter, \bar{x}_i the result of the study, and n_i the number of subject in the study.

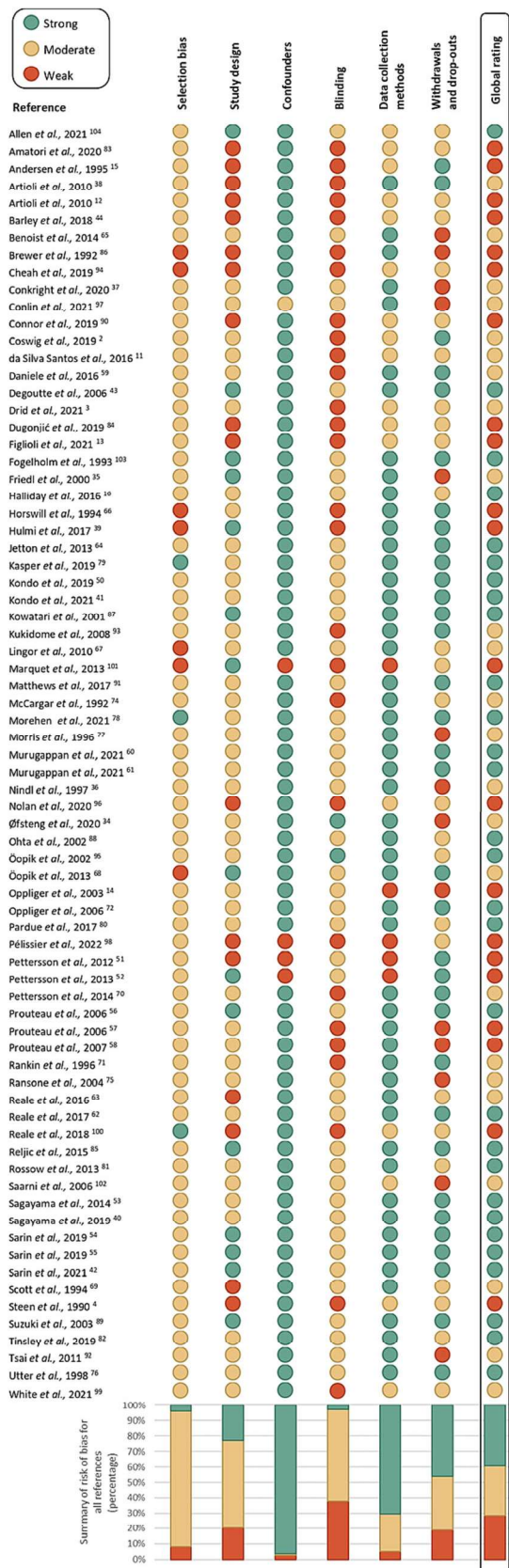


FIGURE 2 Traffic light plot representing the risk of bias analysis and summary in each domain of the “Quality assessment tool for quantitative studies.” (green: strong, orange: medium, red: weak quality rating).

3.4.1 | WL methods and WG conditions

Actual EI and expenditure in longitudinal studies during the WL and WG phases were described in Table S3. Given the inclusion criteria of the articles, WL conditions necessarily involve energy restriction in both interventional and non-interventional studies and were complemented by other methods as described in Table 1. The majority of athletes (>50% of the samples) are used to gradually diet and increase exercise to lose weight. Eighty percent to 97% of the combat sports and powerlifting competitors were engaged in rapid weight loss (RWL)^{4,12,44,96} and seemed to involve more extreme WL methods than bodybuilding¹⁵ or fitness athletes^{39,42,54,55} such as fasting (34.3%, $N = 17$), fluid restrictions (54.9%, $N = 17$), heated training rooms (42.3%, $N = 15$), saunas (30.9%, $N = 17$), training with plastic suits (34.3%, $N = 17$), spitting (26.4%, $N = 16$), laxatives (11.7%, $N = 15$), diuretics (9.9%, $N = 14$), diet pills (6.9%, $N = 13$), or vomiting (3.8%, $N = 1$).^{2-4,11-13,44,67,83,84,90,91,94,96,98-100}

3.4.2 | BW, FM, and FFM variations after WL and WG in combat sports

Pre-WL versus WL

Athletes practicing combat sports significantly lost an average weight of $4.6 \pm 2.3\%$ of BW_{pre-WL} ^{2-4,11-14,38,40,41,43,44,50,53,67,71,78,79,83-85,87-95,99,100,103} for a WL duration from 3 days⁴ to 2 months⁷⁹ in non-interventional studies and can decline to less than 3 days for interventional studies.^{41,50,95,103} Among the eight articles with apparent statistics,^{40,43,53,56,85,87,88,92} a significant loss in FM (%) was observed in five groups^{40,43,53,87,88} ($p < 0.05$), and one of them noticed a significant increase after 14 days of WL ($p < 0.05$).⁹² Moreover, a significant decrease in FFM (kg) ($p < 0.05$) was found in 8^{38,40,41,43,53,85,87,93} out of 10 articles with apparent statistics.^{38,40,41,43,50,53,85,87,88,93}

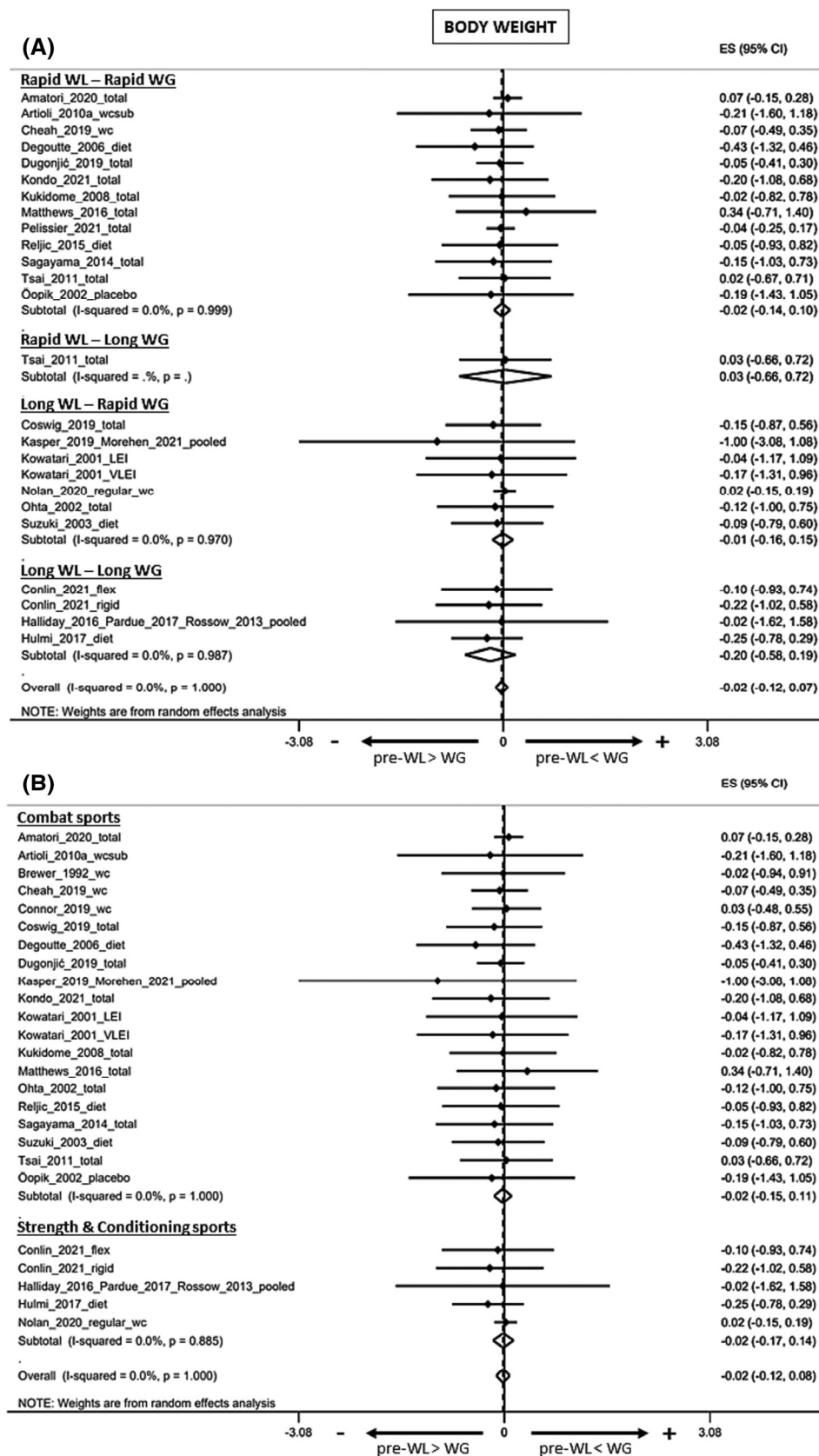
WL versus WG

The end of the diet marked the beginning of the WG period. The average last time point measurement during the WG phase was determined by the study design and conducted 4.6 ± 3.9 days (range: 0.1–27.0 days) after the end of the WL by all but one study, which was conducted post-season.⁴ Combat sports athletes regained a mean of $5.5 \pm 2.4\%$ of BW_{WL} .^{2-4,11-14,38,40,41,43,44,50,53,67,71,78,79,83-85,87-95,99,100,103}

Pre-WL versus WG

Among the 13 studies that reported apparent statistics regarding BW_{pre-WL} versus BW_{WG} , 8 did not notice any significant change (-0.49 ± 0.18 kg after 8.1 ± 8.7 days of WG),^{43,63,85,87,88,91-93} whereas 5 of them highlighted a significant decrease of BW (-1.36 ± 0.04 kg within 3.1 ± 3.4 days of WG, $p < 0.05$).^{41,50,53,89,95} Four^{41,50,87,92} up to six studies^{41,50,53,87,88,92} denote a significant decrease in FM (kg) between pre-WL and WG, whereas one study shows a significant increase.⁵³ Compared with pre-WL values, six

FIGURE 3 Effect size forest plot for body weight gain after an episode of weight loss depending on the duration of the weight loss and weight regain period (mean ± 95% confidence intervals) (A) and on the type of sports (mean ± 95% confidence intervals) (B). VLEI/LEI: very/low energy intake; WC: weight cyclers; WCsub: weight cyclers subgroup; WG: weight gain; WL: weight loss.



articles do not report any significant changes in FFM at the end of the WG period,^{50,53,56,85,87,88} and Kondo and collaborators⁴¹ noted a significant increase of 1.2 kg ($p < 0.05$).

Season scale

Five articles studied weight variations at an entire season scale. Significant changes in BW between pre- (pre-WL) and post-season

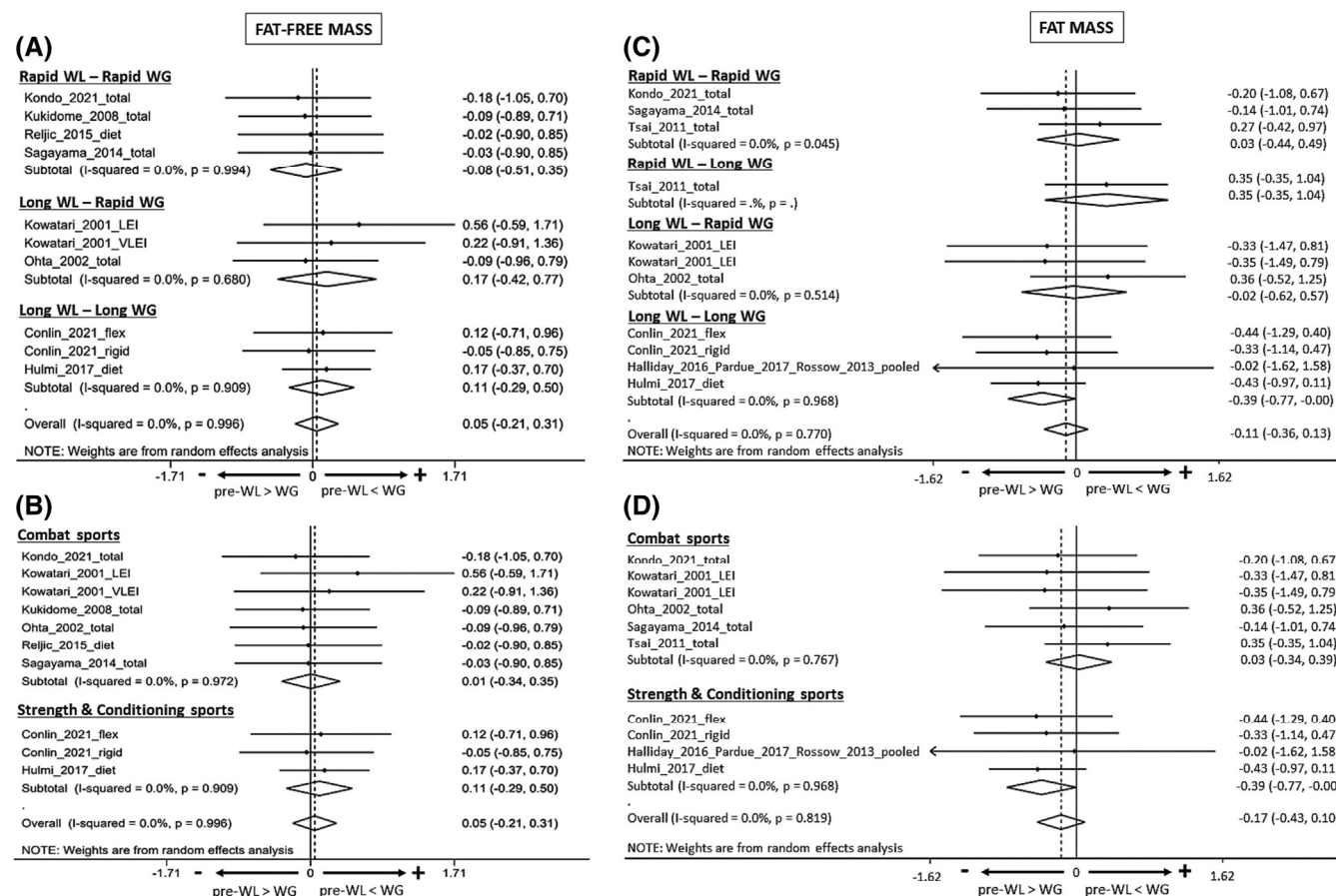


FIGURE 4 Effect size forest plot for fat-free mass (kg) gain after an episode of weight loss depending on the duration of the weight loss and weight regain period (mean \pm 95% confidence intervals) (A) and on the type of sports (mean \pm 95% confidence intervals) (B). Effect size forest plot for fat mass (kg) gain after an episode of weight loss depending on the duration of the weight loss and weight regain period (mean \pm 95% confidence intervals) (C) and on the type of sports (mean \pm 95% confidence intervals) (D). VLEI/LEI: very/low energy intake; WG: weight gain; WL: weight loss.

(WG) were found in two of them but not in the same direction. A significant increase of BW was denoted by McCargar and Crawford⁷⁴ (BW_{pre-WL} : 72.4 ± 11.9 kg vs. BW_{WG} : 73.9 ± 10.5 kg, $p = 0.007$), whereas Utter and Kang⁷⁶ reported a significant decrease (BW_{pre-WL} : 79.4 ± 12.6 vs. BW_{WG} : 77.7 ± 11.6 , $p < 0.03$). Only one article statically compared FM and FFM pre- and post-season, but no significant changes were observed.⁸⁶

3.4.3 | BW, FM, and FFM variations after WL and WG in strength and conditioning sports

WL versus pre-WL

Of the 9 articles that followed strength and conditioning athletes whose actual WL duration was known,^{16,39,54,55,80–82,96,97} 4 were case studies.^{16,80–82} The subject-adjusted mean indicates a loss of $5.5 \pm 4.1\%$ of BW_{pre-WL} in 1⁸² to 7 months⁸⁰ of diet. The apparent statistics regarding body composition pre-WL versus WL were

described in five articles.^{39,42,54,55,97} All reported a significant decrease in FM (kg and %), but no changes were observed in the evolution of FFM (kg).

WG versus WL

WG was estimated at $5.6 \pm 3.5\%$ of BW_{WL} after 44.4 ± 57.9 days (range: 5–497 days) of recovery period. An increase in FM was highlighted and considered as significant in the two articles with apparent statistics ($p < 0.05$),^{39,97} whereas a stable FFM was denoted.^{39,54,55,81,82,97} Although these variations were observed for the RIGID diet group in the Conlin et al.'s study, the FLEX group had a significant increase in FFM, and no changes were observed for FM (kg).⁹⁷

WG versus pre-WL

Apparent statistics on BW and body composition between pre-WL- and WG were made on the cohort studied by Hulmi et al.³⁹ and on its subgroup studied in Sarin and collaborators articles.^{42,54,55} In both

TABLE 1 Main results of the RWLQ and similar questionnaires used to assess weight habits and subsequent weight loss and regain (mean ± SD).

Ref	Group (n)	Dieters' usual WL methods (% of sample, sum of 'always' and 'sometimes' answers)															
		Gradual diet	Skip meals/food restriction	Fast	Fluid restriction	Water load	Increased exercise	Heated training room	Sauna	Hot bath	Train with rubber/plastic suits	Use plastic suits all day	Spit	Vomit	Laxative	Diuretic	Diet pill
83	Cluster1 (133)	75	8	34	26	NE	81	23	4	NE	6	35	5	2	4	2	2
	Cluster2 (31)	71	58	71	76	NE	87	55	23	NE	64	77	29	7	32	30	30
84	total (61)	80	62	36	64	NE	85	51	64	NE	57	13	34	2	5	5	10
99	WC (115)	80	61	43	49	NE	71	31	41	NE	14	11	14	9	13	5	9
12	total (822)	53	60	36	51	NE	87	55	16	NE	40	30	47	3	11	8	3
90	WC (29)	86	48	55	79	90	66	48	48	NE	45	NR	28	NR	21	NR	NR
2	total (15)	NR	NR	NR	NR	NE	NR	NR	NR	NE	NR	NR	NR	NR	NR	NR	NR
	winners (8)	NR	NR	NR	NR	NE	NR	NR	NR	NE	NR	NR	NR	NR	NR	NR	NR
	losers (7)	NR	NR	NR	NR	NE	NR	NR	NR	NE	NR	NR	NR	NR	NR	NR	NR
91	total (7)	86	43	71	100	100	85	14	74	58	57	NR	14	0	14	14	0
3	total (173)	80	77	45	62	NE	58	61	76	NE	64	37	45	10	16	13	11
	m (132)	79	68	39	60	NE	52	60	75	NE	65	37	50	10	18	80	11
	f (67)	84	77	58	67	NE	70	63	77	NE	61	39	33	9	12	80	11
13	seniors (57)	76	65	42	56	NE	56	53	70	NE	67	32	46	5	14	9	7
	juniors (46)	78	67	37	59	NE	48	70	80	NE	70	46	57	11	26	20	17
11	R WC m (24)	64	24	32	44	NE	88	68	12	NE	60	12	12	NR	12	100	100
	R WC f (8)	75	88	50	63	NE	88	25	88	NE	38	25	100	NR	100	100	100
	IN WC m (31)	55	58	42	71	NE	77	52	23	NE	58	10	42	NR	23	19	94
	IN WC f (31)	61	65	45	55	NE	84	52	23	NE	68	6	29	NR	26	23	13
67	initial (13)	NR	92	62	77	NE	92	NE	62	38	31	NE	46	8	NE	NE	NE
14	total (741)	80	46	8	21	NE	75	26	6	NE	6	NE	9	NR	NR	NR	NR
	LW (NR)	78	49	8	18	NE	78	31	5	NE	7	NE	10	NR	NR	NR	NR
	MW (NR)	83	45	6	21	NE	74	34	8	NE	6	NE	9	NR	NR	NR	NR

Ref	Group (n)	Dieters' usual WL methods (% of sample, sum of 'always' and 'sometimes' answers)															
		Gradual diet	Skip meals/food restriction	Fast	Fluid restriction	Water load	Increased exercise	Heated training room	Sauna	Hot bath	Train with rubber/plastic suits	Use plastic suits all day	Spit	Vomit	Laxative	Diuretic	Diet pill
4	HW (NR)	77	41	9	22	NE	74	22	4	NE	4	NE	9	NR	NR	NR	NR
	collegiate (63)	NE	90	63	90	NE	NE	NE	45	NE	85	NR	NR	2	3	3	NR
44	total (637)	83	61	49	79	53	85	51	51	NE	43	11	23	2	9	9	5
	BJJ (159#)	92	53 ^u	33 ^u	68	50	86	38 ^u	36 ^u	NE	16 ^u	6 ^u	4	1	9	8	1
	boxing (38#)	86	36 ^{s£}	36	68	64	86	45 ^s	50	NE	50	18	23 ^u	0	9	9	5
	judo (76#)	66 ^s	66 [†]	54	84	41 ^u	82	43 [£]	43 ^s	NE	23 ^s	7	18 ^s	5	9	5	2
	MMA (70#)	93 ^{s£}	57	48	76	67 ^u	78	63	76 ^s	NE	63 ^{s£†}	20	30 [£]	2	0	7	7
	MT/K (76#)	87	49 ^{*-}	44	76	62	82	44 [†]	51	NE	40	4	20 [†]	0	9	9	7
	TKD (38#)	92	84 ^{s*}	68 ^u	84	48	88	40 [•]	48	NE	28 [£]	8	20	4	16	12	8
	wrestling (172#)	67 [£]	84 ^{u£†-}	57 ^u	94	37 ^s	95	83 ^{u£†*}	50 ^u	NE	83 ^{u†}	17 ^u	47 ^{u£†}	5	12	12	6
94	WC (43)	84	54	56	40	NE	91	56	14	NE	40	26	9	9	2	5	2
100	boxing (71)	92	56	24	72	20	77	49	56	NE	69	13	30	0	9	10	3
	judo (68)	77	54	54	75	30	73	34	53	NE	34	10	19	0	9	3	0
	TKD (57)	91	72	60	82	26	81	30	56	NE	23	2	14	4	14	5	2
	wrestling (33)	73	67	70	82	42	67	47	67	NE	38	9	24	6	3	3	3
15	total (45)	68	NE	12	9	NE	NE	NE	9	NE	NE	NE	NE	NE	NE	NE	NE
96	WC (200)	79	38	19	88	77	25	3	19	31	2	3	26	NR	19	13	3
98	total (168)	51	53	31	54	NE	76	47	42	NE	59	29	9	5	9	9	2
104	WC (190)	36	NE	NE	NE	NE	38	NE	NE	NE	NE	NE	NE				NE
	non-WC (385)	21	NE	NE	NE	NE	26	NE	NE	NE	NE	NE	NE				NE

Ref	Group (n)	Current weight / Inter-season weight (kg)	Age began weight cutting (y)	N° of WL last season (times or % of competitions)	Usual WL duration (d)	Most WL (kg or %BW)	Usual WL (kg or %BW)	Usual WG 1wk after competition (kg or %BW)	RWLQ score
83	Cluster1 (133)	68.5±11.0	18.5	1.6	12.1±9.6	4.5±3.5	1.5±1.3	2.0±1.6	18
	Cluster2 (31)	70.8±17.0	17.8	2.5	16.9±15.0	6.4±3.9	2.5±2.3	4.3±2.7	33
84	total (61)	73.9±12.8	18.5±2.8	3.2±2.4	9.6±8.4	6.2±2.9	3.5±1.5	2.8±1.4	52.4±12.9
99	WC (115)	78.9±9.3	NR	1.6±2.1	NR	5.1±3.2	2.7±2.0	2.3±1.6	NR
12	total (822)	71.1±19.4	12.6±6.1	3 ± 5	7±7	4.0±3.1	1.6±1.6	1.6±1.4	25.9
90	WC (29)	78.3±9.8	NR	NR	NR	NR	6.2±2.8	6.6±2.8	37.9±9.6
	total (15)	89.9±17.3	NR	6 to 12	NR	NR	14±4	NR	NR
2	winners (8)	NR	NR	NR	NR	NR	NR	NR	52.8±10.8
	losers (7)	NR	NR	NR	NR	NR	NR	NR	48.4±23.7
91	total (7)	69.9±5.7	NR	NR	NR	NR	NR	NR	NR
	total (173)	NR	15.8±3.5	NR	11.9±9.5	NR	5.3±7.6	6.64	NR
3	m (132)	75.2±17.8	16.2±3.6	4.4±8.4	11.0±9.9	14.60	8.82	8.06	NR
	f (67)	64.6±14.9	14.9±3.3	3.5±3.0	12.0±9.1	13.30	3.3	3.83	NR
13	seniors (57)	76.3±17.8	17.6±4.7	3.1±2.1	12.4±12.1	8.5±9.3	5.7±7.2	4.6±2.6	NR
	juniors (46)	74.4±16.3	14.0±3.9	3.4±2.5	10.8±7.5	7.4±3.5	4.1±2.1	4.1±2.6	NR
11	R WC m (24)	70.3±16.7£	18.3±4.9	2±4	10±8	4.3±3.9	1.6±1.4	1.2±1.0	43.3±21.3
	R WC f (8)	61.2±9.4£	22.5±5.3*	2±1	19±19	4.3±2.7	2.2±1.9	1.3±0.8	35.0±10.4
	IN WC m (31)	73.0±17.7	17.6±3.6	3±3	10±7	5.3±3.1	2.2±1.7	2.0±1.5	60.9±37.5
	IN WC f (31)	54.8±9.1	16.2±2.3	4±4	12±12	4.6±2.6	1.8±1.1	1.6±1.1	57.3±47.1
67	initial (13)	73.9	NE	NE	7	NE	3.4±0.3	NE	N/A
	total (741)	73.2±10.2	13.7±3.4	NE	NE	NR	NE	NE	N/A
14	LW (NR)	63.8 ± 4.5	13.9±3.4	NE	NE	5.2±2.5	NE	NE	N/A
	MW (NR)	74.7 ± 4.4	14.0±2.5	NE	NE	5.0±2.7	NE	NE	N/A
	HW (NR)	86.6 ± 6.6	13.1±4.5	NE	NE	5.6±3.7	NE	NE	N/A
4	collegiate (63)	NR	14.0±2.0	15.0±13.1	3	7.2±3.2	4.4±2.1	NE	N/A
	total (637)	NR	NR	NR	NR	NR	NR	NR	NR
44	BJJ (159#)	80.9±19.3	NR		18±19	6.7±4.6	4.2±2.6	3.2	NR
	boxing (38#)	77.5±13.9	NR	see	26±26	8.5±4.8	5.3±2.9	4.0	NR
	judo (76#)	81.2±13.1	NR	Table S4	14±16	8.1±8.2	3.8±2.1	3.1	NR
	MMA (70#)	82.8±12.6	NR		27±24	10.4±4.2	9.8±7.9*	7.8	NR

Ref	Group (n)	Current weight / Inter-season weight (kg)	Age began weight cutting (y)	N° of WL last season (times or % of competitions)	Usual WL duration (d)	Most WL (kg or %BW)	Usual WL (kg or %BW)	Usual WG 1wk after competition (kg or %BW)	RWLQ score
	MT/K (76#)	75.2±13.7	NR		21±20	6.9±3.5	5.9±3.5	4.6	NR
	TKD (38#)	65.3±13.0	NR		28±48	6.5±3.3	4±3	3.6	NR
	wrestling (172#)	74.3±13.9	NR		7±9	7.1±4.2	4.4±3.7	4.4	NR
94	WC (43)	<i>63.4±13.1</i>	NR	NR	3.1±6.3	4.9±3.2	3.4±1.9	2.5	NR
100	boxing (71)	65.6±11.3	19.3±4.9	68.2±32.4%	12.3±10.3	8.3±4.9%	3.6±2.1%	4.1±2.4%	30.5±11.0
	judo (68)	68.3±15.8	17.1±5.5	70.6±32.0%	11.3±8.3	6.9±3.0%	3.8±2.2%	3.6±2.0%	29.5±9.7
	TKD (57)	64.2±12.1	17.3±4.0	70.1±30.0%	16.9±15.7	9.3±4.5%	4.6±2.2%	4.6±2.6%	31.7±11.3
	wrestling (33)	72.4±11.1	20.5±8.7	60.0±35.7%	10±8.1	11.0±6.5%	4.9±3.7%	4.8±3.6%	31.4±11.5
15	total (45)	NR	21.5±7.4	1.2±0.1	NE	6.8±4.0	NE	NE	N/A
96	WC (200)	NR	NR	67.3±34.4%	NR	4.2±2.5	2.4±1.5	3.2±1.6	25.1±7.4
98	total (168)	67.2±12.2	17.1±6.5	NR	13.1±9.6	5.1±2.6	2.8±2.0	2.3±1.9	31.9±17.3
104	WC (190)	NR	NE	NE	NE	NE	NE	N/A	N/A
	non-WC (385)	NR	NE	NE	NE	NE	NE	N/A	N/A

Note: The dieters' usual WL methods results have been rounded to the unit, and other results have been rounded to the nearest 10th of a unit. The column "Group" refers to the subgroups identified in Table S2. Italic: raw data. Colors range from red (method used by 0% of athletes) to green (method used by 100% of athletes).

Abbreviations: BJJ, Brazilian Jiu-Jitsu; BW, body weight; d, day; f, female; HW, heavy weight; IN, international; LW, light weight; m, male; MMA, mixed martial art; MT/K, muay thai/kickboxing; MW, middle weight; N°, number; N/A, not applicable; NE, not evaluated; NR, not reported; R, regional; RWLQ, Rapid Weight Loss Questionnaire; TKD, taekwondo; WC, weight cyclers; WG, weight gain; wk, week; WL, weight loss; y, year.

^a: n calculated with the percentage in each sport given in the original article (n total = 637, 25% BJJ, 6% boxing, 12% Judo, 11% MMA, 12% MT/K, 6% TKD, and 27% in wrestling).

^{*}Significant difference with all other groups from the same article.

^{†,‡,§,¶,•}Significant difference between groups with the same symbol from a same article.

cohorts, a significant decrease in BW and FM (kg) was reported ($p < 0.05$), whereas a significant increase in FFM (kg) was only pointed out in the subgroup cohort ($p < 0.05$).

Season scale

In their study, Morris and Payne⁷⁷ did not denote any changes in BW, FM, and FFM between pre- and post-season for rowing athletes, although significant changes of BW and FM (kg and %) were observed throughout the season ($p < 0.05$).

3.4.4 | Training camp and subsequent BW, FM, and FFM variations after WL and WG in soldiers

WL versus pre-WL

Four^{34–37} out of 5^{34–37,104} studies followed soldiers in training camps and/or ranger courses. Three studies realized BW, FM, and FFM measures at the end of 10³⁴ or 62 days^{35,104} of imposed energy restriction and a high level of military exercises. All soldiers significantly lose BW with an average WL of $9.1 \pm 2.8\%$ of BW_{pre-WL} . FM and FFM evolution were statistically compared between pre-WL and WL in two articles.^{34,36} If a significant decrease in FM (kg) was observed in both, a significant decrease in FFM was only found in the Nindl et al.'s study.³⁶

WG versus WL

After a recovery phase of 7–35 days, the soldiers significantly regained an average of $12.7 \pm 5.8\%$ of BW_{WL} . Two studies reported the body composition after recovery and noticed an average increase in FM of 8.5 ± 0.2 kg and in FFM of 5.4 ± 0.3 kg.^{35,36}

WG versus pre-WL

Significant increases in BW and FM (kg and %) were observed in 2^{36,37} of the 4 studies^{34–37} with apparent statistics between pre-WL and WG ($p < 0.05$) but no significant results regarding FFM were found (kg).

3.4.5 | Does dieting increase the risk for greater fat gain after WG than pre-WL in athletes? Meta-analyses

Given the multitude of variables to consider, 84 meta-analyses were performed with a total of 27 studies.^{2,16,38,39,41,43,53,78–81,83–98} For a better understanding, results were presented in Table 2, and included studies in meta-analyses were detailed in Table S4. WL and WG durations were considered as “rapid” if they lasted 14 days or less (RWL, RWG) and considered as “long” otherwise (LWL, LWG). Regarding pre-WL versus WG, no heterogeneity was found in any of the meta-analyses performed (Table 2a). A significant loss in FM (kg) can be observed for strength and conditioning athletes, corresponding to the same athletes having a LWL \times LWG duration (ES: -0.39 , 95% CI: $[-0.77; -0.00]$, $p = 0.048$, $I^2 = 0.0\%$). Otherwise, no significant results were found regarding BW (kg), FM (%), and FFM (kg) between pre-WL and WG time points, despite significant variations observed in the pre-WL versus WL and WL versus WG as described in Table 2b,c.

3.5 | Side effects of weight variations in athletes

Additional results were synthesized in the Table 3 and detailed in the Table S5. Among the nine articles reporting statistics for additional anthropometric and body composition,^{35,39,41,54,55,67,74,76,77} no significant changes were observed between pre-WL and WG for all except for one cohort described in two articles, which noticed a significant decrease in waist circumference in strength and conditioning athletes combining an LWL and LWG periods.^{54,55}

Regarding statistics about biological parameters, a significant increase was observed for blood glucose concentration in 1³⁸ out of 6 studies,^{38,41,42,71,86,95} whereas other studies did not notice any changes. An increase in TG concentration was also reported by two articles with statistics after a RWL followed by an RWG in combat sports athletes,^{43,50} and no changes were observed after a RWL \times LWG period.⁸⁸ Among the two studies regarding total-C evolution, no changes were observed for combat sport athletes after a RWL \times RWG period, whereas a significant increase was observed in soldiers after a RWL \times LWG period.³⁵

No changes in REE were observed in any articles at the end of the WL period and after the recovery period ($N = 4$).^{53,74,86,97} However, Sagayama et al. noticed a significant decrease in CHO and an increase in lipid oxidation during an incremental exercise after a RWL \times RWG duration.⁴⁰ A significant decrease in physical fitness was observed in at least one study for each parameter between pre-WL and WG.^{34,37,39,40,43,58} A positive correlation was observed between the amount of WG and fight issues in combat sports athletes (winners WG > losers WG) in two articles,^{2,63} whereas three others do not find any differences.^{59,66,76}

Although no significant differences were observed in the mood profile among fitness athletes after an LWL \times LWG period,³⁹ an increase in tension and fatigue and a decrease in vigor can be observed among combat athletes after a RWL \times RWG period.⁵³

No significant differences were found after the WG period when compared with CT for additional results (Table 3b), except for upper limb strength.³⁹

4 | DISCUSSION

The present work is, to our knowledge, the first to systematically and meta-analytically assess the BW regain in response to a WL episode in WC athletes, depending on the methods used to achieve WL and the type of practiced sport (main aim). It additionally analyzes for the first time these responses in terms of body composition and additional parameters such as performance, metabolism, or psychological status (secondary aims).

According to the results obtained through both our systematic and meta-analyses, WC athletes do not seem to experience increased BW after an episode of WL compared with their pre-WL values, whatever their practiced sport or the methods used, as illustrated in the forest-plot in Figure 3. While similar results are observed for FFM, athletes practicing strength and conditioning sports (longer WL and WG periods) do not seem to fully recover their initial (pre-WL) FM, as

TABLE 2 Meta-analyses results on body weight, fat mass, and fat-free mass for a) pre-WL vs. WG, b) pre-WL vs. WL, and c) WL vs. WG.

		BW (kg)							FM (kg)						
		n	ES [95% CI]	p	I ² (%)	P	tau ²	Q	n	ES [95% CI]	p	I ² (%)	P	tau ²	Q
Sex	male	20	-0.03 [-0.17 ; 0.10]	0,64	0,0	1,00	0,00	3,6	6	0.03 [-0.34 ; 0.39]	0,88	0,0	0,77	0,00	2,6
	female	4	-0.07 [-0.39 ; 0.25]	0,67	0,0	0,82	0,00	0,9	1	-	-	NA	NA	NA	NA
	overall	24	-0.04 [-0.17 ; 0.09]	0,55	0,0	1,00	0,00	4,6	7	-0.12 [-0.41 ; 0.19]	0,45	0,0	0,62	0,00	4,5
Diet status	DIET/WC	26	-0.02 [-0.12 ; 0.07]	0,61	0,0	1,00	0,00	4,8	10	-0.17 [-0.44 ; 0.10]	0,21	0,0	0,82	0,00	5,2
	non-DIET/WC	6	0.05 [-0.26 ; 0.37]	0,75	0,0	0,99	0,00	0,5	2	-	-	-	-	-	
	overall	32	-0.02 [-0.11 ; 0.07]	0,68	0,0	1,00	0,00	5,4	12	-0.13 [-0.36 ; 0.11]	0,29	0,0	0,90	0,00	5,7
Sport category	combat sports	20	-0.02 [-0.16 ; 0.11]	0,73	0,0	1,00	0,00	3,6	6	0.03 [-0.34 ; 0.40]	0,88	0,0	0,77	0,00	2,6
	strength sports	5	-0.02 [-0.17 ; 0.14]	0,84	0,0	0,89	0,00	1,2	4	-0.39 [-0.77 ; 0.00]	0,05	0,0	0,97	0,00	0,3
	overall	25	-0.02 [-0.12 ; 0.08]	0,69	0,0	1,00	0,00	4,7	10	-0.17 [-0.44 ; 0.10]	0,21	0,0	0,82	0,00	5,2
WL duration	]0;7] days	9	-0.01 [-0.36 ; 0.17]	0,46	0,0	1,00	0,00	1,4	2	-	-	-	-	-	
	]7;14] days	4	0.00 [-0.14 ; 0.14]	0,97	0,0	0,90	0,00	0,6	1	-	-	NA	NA	NA	NA
	]14;31] days	5	-0.12 [-0.50 ; 0.26]	0,54	0,0	1,00	0,00	0,0	3	-0.02 [-0.62 ; 0.57]	0,94	0,0	0,51	0,00	1,3
	]1;3] months	3	-0.22 [-0.78 ; 0.34]	0,44	0,0	0,73	0,00	0,6	2	-	-	-	-	-	
	]3;6] months	2	-	-	-	-	-	-	2	-	-	-	-	-	
	overall	23	-0.05 [-0.16 ; 0.07]	0,43	0,0	1,00	0,00	4,3	10	-0.17 [-0.34 ; 0.10]	0,21	0,0	0,82	0,00	5,2
WG duration	]0;1] day	9	-0.19 [-0.49 ; 0.11]	0,22	0,0	1,00	0,00	1,2	3	0.00 [-0.46 ; 0.46]	1,00	0,0	0,71	0,00	0,7
	]1;7] days	11	0.00 [-0.09 ; 0.10]	0,91	0,0	1,00	0,00	1,2	2	-	-	-	-	-	
	]7;14] days	3	-0.10 [-0.62 ; 0.43]	0,71	0,0	0,99	0,00	0,0	2	-	-	-	-	-	
	]14;31] days	2	-	-	-	-	-	-	1	-	-	NA	NA	NA	NA
	]1;3] months	3	-0.16 [-0.71 ; 0.38]	0,56	0,0	0,98	0,00	0,0	2	-	-	-	-	-	
	]3;7] months	3	-0.18 [-0.62 ; 0.27]	0,44	0,0	0,90	0,00	0,2	2	-	-	-	-	-	
	overall	31	-0.03 [-0.12 ; 0.06]	0,55	0,0	1,00	0,00	5,7	12	-0.08 [-0.31 ; 0.16]	0,52	0,0	0,78	0,00	7,3
WG > 1 day	overall	23	-0.01 [-0.10 ; 0.08]	0,83	0,0	1,00	0,00	2,5	8	-0.17 [-0.46 ; 0.12]	0,26	0,0	0,64	0,00	5,2
WL x WG duration^{\$}	RWL x RWG	13	-0.02 [-0.14 ; 0.10]	0,76	0,0	1,00	0,00	2,4	3	-0.03 [-0.44 ; 0.49]	0,92	0,0	0,65	0,00	0,9
	RWL x LWG	1	-	-	NA	NA	NA	NA	1	-	-	NA	NA	NA	NA
	LWL x RWG	7	-0.00 [-0.16 ; 0.15]	0,91	0,0	0,97	0,00	1,3	3	-0.02 [-0.62 ; 0.57]	0,94	0,0	0,51	0,00	1,3
	LWL x LWG	4	-0.20 [-0.58 ; 0.19]	0,31	0,0	0,99	0,00	0,1	4	-0.39 [-0.77 ; -0.00]	0,05	0,0	0,97	0,00	0,3
	overall	25	-0.03 [-0.12 ; 0.07]	0,59	0,0	1,00	0,00	4,7	11	-0.11 [-0.36 ; 0.13]	0,37	0,0	0,77	0,00	6,5

TABLE 2 (Continued)

2a pre-WL vs. WG		FM (%)							FFM (kg)						
		n	ES [95% CI]	p	I ² (%)	P	tau ²	Q	n	ES [95% CI]	p	I ² (%)	P	tau ²	Q
Sex	male	8	-0.05 [-0.36 ; 0.26]	0,77	0,0	0,55	0,00	5,9	8	-0.03 [-0.35 ; 0.29]	0,86	0,0	0,98	0,00	1,5
	female	NA	NA	NA	NA	NA	NA	NA	1	-	-	NA	NA	0,00	0,0
	overall	8	-0.05 [-0.36 ; 0.26]	0,77	0,0	0,55	0,00	5,9	9	0.02 [-0.37 ; 0.30]	0,87	0,0	0,98	0,00	1,9
Diet status	DIET/WC	10	-0.09 [-0.37 ; 0.20]	0,55	0,0	0,70	0,00	5,7	10	0.05 [-0.21 ; 0.31]	0,71	0,0	1,00	0,00	1,6
	non-DIET/WC	2	-	-	-	-	-	-	3	-0.00 [-0.46 ; 0.45]	0,99	0,0	0,97	0,00	0,1
	overall	12	-0.08 [-0.35 ; 0.19]	0,56	0,0	0,85	0,00	6,4	13	0.04 [-0.19 ; 0.26]	0,75	0,0	1,00	0,00	1,7
Sport category	combat sports	7	-0.02 [-0.35 ; 0.32]	0,92	0,0	0,46	0,00	6,4	7	0.00 [-0.34 ; 0.35]	0,98	0,0	0,97	0,00	1,3
	strength sports	3	-0.27 [-0.82 ; 0.28]	0,33	0,0	0,96	0,00	0,0	3	0.11 [-0.29 ; 0.50]	0,60	0,0	0,91	0,00	0,2
	overall	10	-0.9 [-0.37 ; 0.20]	0,55	0,0	0,70	0,00	6,4	10	0.05 [-0.21 ; 0.31]	0,71	0,0	1,00	0,00	1,6
WL duration	]0;7] days	3	0.05 [-0.44 ; 0.54]	0,84	0,0	0,64	0,00	0,9	4	-0.08 [-0.51 ; 0.35]	0,71	0,0	0,99	0,00	0,1
	]7;14] days	1	-	-	NA	NA	NA	NA	0	NA	NA	NA	NA	NA	NA
	]14;31] days	3	-0.50 [-1.10 ; 0.10]	0,11	0,0	0,91	0,00	0,2	3	0.17 [-0.42 ; 0.77]	0,57	0,0	0,68	0,00	0,1
	]1;3] months	2	-	-	0,0	0,97	0,00	0,0	2	-	-	-	-	-	-
	]3;6] months	1	-	-	NA	NA	NA	NA	1	-	-	NA	NA	NA	NA
	overall	10	-0.09 [-0.37 ; 0.20]	0,55	0,0	0,70	0,00	6,4	10	0.05 [-0.21 ; 0.31]	0,71	0,0	1,00	0,00	1,6
WG duration	]0;1] day	3	0.03 [-0.45 ; 1.17]	0,89	0,0	0,55	0,00	1,2	3	-0.14 [-0.63 ; 0.35]	0,58	0,0	0,95	0,00	0,1
	]1;7] days	4	0.05 [-0.42 ; 0.52]	0,83	24,2	0,27	0,00	4,0	3	-0.07 [-0.56 ; 0.42]	0,78	0,0	0,99	0,00	0,0
	]7;14] days	2	-	-	0,0	0,98	0,00	0,0	2	-	-	-	-	-	-
	]14;31] days	1	-	-	NA	NA	NA	NA	0	NA	NA	NA	NA	NA	NA
	]1;3] months	2	-	-	0,0	0,97	0,00	0,0	2	-	-	-	-	-	-
	]3;7] months	1	-	-	NA	NA	NA	NA	1	-	-	NA	NA	NA	NA
	overall	13	0.00 [-0.23 ; 0.24]	0,97	0,0	0,70	0,00	9,1	11	0.03 [-0.22 ; 0.27]	0,84	0,0	1,00	0,00	2,0
	WG > 1 day	overall	9	-0.08 [-0.38 ; 0.22]	0,60	0,0	0,61	0,00	6,4	8	0.08 [-0.21 ; 0.37]	0,58	0,0	0,99	0,00	1,3
WL x WG duration^{\$}	RWL x RWG	4	0.17 [-0.24 ; 0.57]	0,42	0,0	0,68	0,00	1,5	4	-0.08 [-0.51 ; 0.35]	0,71	0,0	0,99	0,00	0,1
	RWL x LWG	1	-	-	NA	NA	NA	NA	0	NA	NA	NA	NA	NA	NA
	LWL x RWG	3	-0.50 [-1.10 ; 0.10]	0,11	0,0	0,91	0,00	0,2	3	0.17 [-0.42 ; 0.77]	0,57	0,0	0,68	0,00	0,8
	LWL x LWG	3	-0.27 [-0.82 ; 0.28]	0,33	0,0	0,96	0,00	0,1	3	0.11 [-0.29 ; 0.50]	0,60	0,0	0,91	0,00	0,2
	overall	11	-0.02 [-0.28 ; 0.25]	0,90	0,0	0,63	0,00	8,0	10	0.05 [-0.21 ; 0.31]	0,71	0,0	1,00	0,00	1,6

(Continues)

TABLE 2 (Continued)

		BW (kg)							FM (kg)						
		<i>n</i>	ES [95% CI]	<i>p</i>	<i>I</i> ² (%)	<i>P</i>	tau ²	<i>Q</i>	<i>n</i>	ES [95% CI]	<i>p</i>	<i>I</i> ² (%)	<i>P</i>	tau ²	<i>Q</i>
Sex	male	24	-0.66 [-0.89;-0.43]	0.00	64.5	0.00	0.18	64.8	6	-0.13 [-0.50;0.23]	0.88	0.0	1.00	0.00	0.4
	female	6	-0.81 [-1.34;-0.28]	0.00	72.3	0.00	0.31	18.1	1	-	-	NA	NA	NA	NA
	overall	30	-0.69 [-0.91;-0.48]	0.00	66.4	0.00	0.20	86.4	7	-0.44 [-1.06;0.18]	0.45	72.6	0.00	0.50	21.9
Diet status	DIET/WC	38	-0.82 [-1.03;-0.61]	0.00	87.4	0.00	0.31	293.7	10	-0.53 [-1.01;-0.05]	0.21	63.6	0.00	0.36	24.8
	non-DIET/WC	6	0.05 [-0.26;0.37]	0.75	0.0	1.00	0.00	0.3	2	-	-	-	-	-	
	overall	44	-0.71 [-0.91;-0.51]	0.00	86.5	0.00	0.32	317.5	12	-0.40 [-0.83;0.02]	0.29	64.5	0.00	0.34	31.0
Sport category	combat sports	32	-0.91 [-1.13;-0.68]	0.00	83.3	0.00	0.27	185.7	6	-0.13 [-0.50;0.23]	0.88	0.0	1.00	0.00	0.4
	strength sports	5	-0.46 [-1.00;0.08]	0.10	71.9	0.01	0.24	14.2	4	-1.14 [-2.04;-0.23]	0.05	73.5	0.01	0.58	11.3
	overall	37	-0.84 [-1.06;-0.63]	0.00	86.7	0.00	0.32	270.0	10	-0.53 [-1.01;-0.05]	0.21	63.6	0.00	0.36	24.8
WL duration	]0;7] days	10	-0.68 [-0.98;-0.38]	0.00	0.0	0.70	0.08	17.1	2	-	-	-	-	-	
	]7;14] days	12	-1.02 [-1.43;-0.61]	0.00	0.0	0.90	0.48	151.5	1	-	-	NA	NA	NA	
	]14;31] days	7	-0.78 [-1.49;-0.08]	0.03	0.0	1.00	0.70	30.0	3	-0.19 [-0.78;0.40]	0.94	0.0	0.96	0.00	
	]1;3] months	3	-0.37 [-0.93;0.19]	0.20	0.0	0.40	0.00	1.8	2	-	-	-	-	-	
	]3;6] months	2	-	-	-	-	-	-	2	-	-	-	-	-	
	overall	34	-0.32 [-0.44;-0.20]	0.00	2.4	0.43	0.30	218.7	10	-0.53 [-1.01;-0.05]	0.21	63.6	0.00	0.36	24.8
WG duration	]0;1] day	9	-0.53 [-0.84;-0.22]	0.00	0.0	0.65	0.00	6.0	3	-0.09 [-0.56;0.37]	1.00	0.0	0.88	0.00	0.3
	]1;7] days	23	-0.93 [-1.19;-0.66]	0.00	92.2	0.00	0.35	280.8	2	-	-	-	-	-	
	]7;14] days	3	-0.36 [-0.88;0.17]	0.19	0.0	0.93	0.00	0.2	2	-	-	-	-	-	
	]14;31] days	1	-	-	NA	NA	NA	NA	1	-	-	NA	NA	NA	
	]1;3] months	2	-	-	-	-	-	-	2	-	-	-	-	-	
	]3;7] months	3	-0.87 [-1.49;-0.24]	0.01	28.6	0.25	0.09	2.8	2	-	-	-	-	-	
	overall	41	-0.78 [-0.99;-0.58]	0.00	86.6	0.00	0.31	299.5	12	-0.42 [-0.82;-0.01]	0.52	62.4	0.00	0.31	29.2
WG > 1 day	overall	31	-0.84 [-1.07;-0.61]	0.00	89.6	0.00	0.33	289.1	8	-0.62 [-1.21;-0.03]	0.26	69.6	0.00	0.47	23.1
WL x WG duration[§]	RWL x RWG	22	-0.88 [-1.14;-0.62]	0.00	88.1	0.00	0.29	176.8	3	-0.09 [-0.56;0.37]	0.92	0.0	0.88	0.00	0.3
	RWL x LWG	1	-	-	NA	NA	NA	NA	1	-	-	NA	NA	NA	
	LWL x RWG	9	-0.74 [-1.4;-0.09]	0.03	88.5	0.00	0.75	69.3	3	-0.19 [-0.78;0.40]	0.94	0.0	0.96	0.00	
	LWL x LWG	4	-0.64 [-1.23;-0.06]	0.03	45.7	0.14	0.16	5.5	4	-1.13 [-2.04;-0.23]	0.05	73.5	0.01	0.58	11.3
	overall	36	-0.80 [-1.02;-0.78]	0.00	87.7	0.00	0.32	285.3	11	-0.47 [-0.91;-0.03]	0.37	63.4	0.00	0.33	27.3

TABLE 2 (Continued)

2b pre-WL vs WL		FM (%)							FFM (kg)						
		n	ES [95% CI]	p	I ² (%)	P	tau ²	Q	n	ES [95% CI]	p	I ² (%)	P	tau ²	Q
Sex	male	8	-0.22 [-0.53;0.09]	0.77	0.0	0.75	0.00	4.3	8	-0.54 [-0.87;-0.22]	0.00	0.0	1.00	0.00	0.9
	female	0	NA	NA	NA	NA	NA	NA	1	-	-	NA	NA	NA	NA
	overall	8	-0.22 [-0.52;0.09]	0.77	0.0	0.75	0.00	4.3	9	-0.37 [-0.65;-0.09]	0.01	0.0	0.77	0.00	4.9
Diet status	DIET/WC	10	-0.33 [-0.67;0.01]	0.55	24.9	0.21	0.07	12.0	10	-0.27 [-0.53;-0.01]	0.05	0.0	0.78	0.00	5.6
	non-DIET/WC	2	-	-	-	-	-	-	3	-0.11 [-0.57;0.35]	0.64	0.0	0.61	0.00	1.0
	overall	12	-0.26 [-0.56;0.04]	0.56	16.0	0.29	0.04	13.1	13	-0.23 [-0.46;-0.00]	0.05	0.0	0.86	0.00	6.9
Sport category	combat sports	7	-0.22 [-0.55;0.12]	0.92	0.0	0.64	0.00	4.3	7	-0.53 [-0.88;-0.18]	0.00	0.0	0.99	0.00	0.8
	strength sports	3	-0.93 [-2.18;0.32]	0.33	70.4	0.03	0.76	6.8	3	0.05 [-0.34;0.44]	0.79	0.0	0.96	0.00	0.1
	overall	10	-0.33 [-0.67;0.01]	0.55	24.9	0.21	0.07	12.0	10	-0.27 [-0.53;-0.01]	0.05	0.0	0.78	0.00	5.6
WL duration	]0;7] days	3	-0.22 [-0.71;0.28]	0.84	0.0	0.97	-	-	4	-0.58 [-1.02;-0.14]	0.01	0.0	0.96	0.00	0.3
	]7;14] days	1	-	-	NA	NA	NA	NA	0	NA	NA	NA	NA	NA	NA
	]14;31] days	3	-0.57 [-1.17;0.04]	0.11	0.0	0.52	0.00	1.3	3	-0.43 [-1.03;0.17]	0.16	0.0	0.83	0.00	0.4
	]1;3] months	2	-	-	-	-	-	-	2	-	-	-	-	-	-
	]3;6] months	1	-	-	NA	NA	-	-	1	-	-	NA	NA	NA	NA
	overall	10	-0.33 [-0.67;0.01]	0.55	24.9	0.21	0.07	12.0	10	-0.27 [-0.53;-0.01]	0.05	0.0	0.78	0.00	5.6
WG duration	]0;1] day	3	-0.01 [-0.46;0.45]	0.89	0.0	0.68	0.00	0.8	3	-0.65 [-1.15;-0.14]	0.01	0.0	0.98	0.00	0.0
	]1;7] days	4	-0.25 [-0.74;0.24]	0.83	29.3	0.24	0.07	4.2	3	-0.42 [-0.92;0.07]	0.10	0.0	0.93	0.00	0.4
	]7;14] days	2	-	-	-	-	-	-	2	-	-	-	-	-	-
	]14;31] days	1	-	-	NA	NA	NA	NA	0	NA	NA	NA	NA	NA	NA
	]1;3] months	2	-	-	-	-	-	-	2	-	-	-	-	-	-
	]3;7] months	1	-	-	NA	NA	NA	NA	1	-	-	NA	NA	NA	NA
	overall	13	-0.19 [-0.47;0.08]	0.97	22.1	0.22	0.06	15.4	11	-0.30 [-0.55;-0.05]	0.02	0.0	0.80	0.00	6.2
WG > 1 day	overall	9	-0.36 [-0.75;0.02]	0.60	32.6	0.16	0.11	11.9	8	-0.19 [-0.48;0.10]	0.20	0.0	0.81	0.00	3.7
WL x WG duration [§]	RWL x RWG	4	-0.07 [-0.47;0.34]	0.42	0.0	0.77	0.00	1.1	4	-0.58 [-1.02;-0.14]	0.01	0.0	0.96	0.00	0.3
	RWL x LWG	1	-	-	NA	NA	NA	NA	0	NA	NA	NA	NA	NA	NA
	LWL x RWG	3	-0.57 [-1.17;0.04]	0.11	0.0	0.52	0.00	1.3	3	-0.43 [-1.03;0.17]	0.16	0.0	0.83	0.00	0.4
	LWL x LWG	3	-0.93 [-2.18;0.32]	0.33	70.4	0.03	0.76	6.8	3	0.05 [-0.34;0.44]	0.79	0.0	0.96	0.00	0.1
	overall	11	-0.26 [-0.58;0.06]	0.90	28.3	0.18	0.08	14.0	10	-0.27 [-0.53;-0.01]	0.05	0.0	0.78	0.00	5.6

(Continues)

TABLE 2 (Continued)

2c WL vs. WG		BW (kg)							FM (kg)						
		n	ES [95% CI]	p	I ² (%)	P	tau ²	Q	n	ES [95% CI]	p	I ² (%)	P	tau ²	Q
Sex	male	24	0.64 [0.38;0.89]	0.00	71.5	0.00	0.25	80.7	6	0.16 [-0.2;0.53]	0.38	0.0	0.94	0.00	1.3
	female	6	0.78 [0.31;1.26]	0.00	65.5	0.01	0.23	14.5	1	-	-	NA	NA	NA	NA
	overall	30	0.34 [0.22;0.47]	0.00	70.1	0.00	0.24	97.0	7	0.39 [-0.13;0.91]	0.14	61.0	0.02	0.29	15.4
Diet status	DIET/WC	38	0.78 [0.56;0.99]	0.00	88.1	0.00	0.34	310.7	10	0.39 [-0.03;0.82]	0.07	55.7	0.02	0.25	20.3
	non-DIET/WC	6	-0.01 [-0.32;0.31]	0.97	0.0	1.00	0.00	0.1	2	-	-	-	-	-	-
	overall	44	0.68 [0.47;0.88]	0.00	87.1	0.00	0.34	333.8	12	0.3 [-0.08;0.67]	0.12	54.7	0.01	0.22	24.3
Sport category	combat sports	32	0.87 [0.65;1.09]	0.00	83.3	0.00	0.30	185.6	6	0.16 [-0.2;0.53]	0.38	0.0	0.94	0.00	1.3
	strength sports	5	0.33 [-0.08;0.74]	0.12	53.3	0.07	0.10	8.6	4	0.82 [-0.14;1.78]	0.09	77.5	0.00	0.68	13.3
	overall	37	0.80 [0.58;1.02]	0.00	87.1	0.00	0.33	279.2	10	0.39 [-0.03;0.82]	0.07	55.7	0.02	0.25	20.3
WL duration	]0;7] days	10	0.59 [0.19;0.98]	0.00	70.6	0.00	0.22	30.6	2	-	-	-	-	-	-
	]7;14] days	12	1.03 [0.62;1.44]	0.00	92.6	0.00	0.47	149.3	1	-	-	NA	NA	NA	NA
	]14;31] days	7	0.72 [0.07;1.37]	0.03	78.2	0.00	0.57	27.6	3	0.17 [-0.42;0.77]	0.93	0.0	0.93	0.0	0.9
	]1;3] months	3	0.18 [-0.38;0.74]	0.52	0.0	0.57	0.00	1.1	2	-	-	-	-	-	-
	]3;6] months	2	-	-	-	-	-	-	2	-	-	-	-	-	-
	overall	34	0.79 [0.57;1.02]	0.00	85.7	0.00	0.31	230.3	10	0.39 [-0.03;0.82]	0.07	55.7	0.02	0.25	20.3
WG duration	]0;1] day	9	0.35 [0.05;0.66]	0.02	0.00	0.98	0.00	2.2	3	0.1 [-0.37;0.56]	0.68	0.0	0.94	0.00	0.1
	]1;7] days	23	0.94 [0.67;1.22]	0.00	92.5	0.00	0.37	294.3	2	-	-	-	-	-	-
	]7;14] days	3	0.27 [-0.25;0.8]	0.31	0.0	0.91	0.00	0.2	2	-	-	-	-	-	-
	]14;31] days	1	-	-	NA	NA	NA	NA	1	-	-	NA	NA	NA	NA
	]1;3] months	2	-	-	-	-	-	-	2	-	-	-	-	-	-
	]3;7] months	3	0.79 [0.32;1.25]	0.00	0.0	0.52	0.00	1.3	2	-	-	-	-	-	-
	overall	41	0.74 [0.53;0.95]	0.00	87.4	0.00	0.33	317.6	12	0.36 [0.02;0.7]	0.04	47.7	0.03	0.17	21.0
WG > 1 day	overall	31	0.83 [0.59;1.07]	0.00	90.2	0.00	0.35	305.1	8	0.49 [-0.00s.03;1]	0.06	61.0	0.01	0.32	18.0
WL x WG duration ^{\$}	RWL x RWG	22	0.85 [0.58;1.13]	0.00	89.2	0.00	0.32	195.0	3	0.12 [-0.34;0.59]	0.60	0.0	0.90	0.00	0.2
	RWL x LWG	1	-	-	NA	NA	NA	NA	1	-	-	NA	NA	NA	NA
	LWL x RWG	9	0.65 [0.07;1.23]	0.00	85.5	0.00	0.56	55.2	3	0.17 [-0.42;0.77]	0.57	0.0	0.65	0.00	0.9
	LWL x LWG	4	0.48 [-0.04;0.99]	0.21	34.0	0.21	0.09	4.6	4	0.82 [-0.14;1.78]	0.09	77.5	0.00	0.68	13.3
	overall	36	0.75 [0.52;0.97]	0.00	88.4	0.00	0.34	300.7	11	0.38 [0.00;0.76]	0.05	51.5	0.02	0.20	20.6

TABLE 2 (Continued)

2c WL vs. WG		FM (%)							FFM (kg)						
		n	ES [95% CI]	p	I ² (%)	P	tau ²	Q	n	ES [95% CI]	p	I ² (%)	P	tau ²	Q
Sex	male	8	0.18 [-0.13;0.48]	0.26	0.0	0.96	0.00	2.1	8	0.51 [0.19;0.84]	0.00	0.0	0.95	0.00	2.15
	female	0	NA	NA	NA	NA	NA	NA	1	-	-	NA	NA	NA	NA
	overall	8	0.18 [-0.13;0.48]	0.26	0.0	0.96	0.00	2.1	9	0.39 [0.12;0.67]	0.01	0.0	0.85	0.00	4.04
Diet status	DIET/WC	10	0.23 [-0.07;0.52]	0.14	5.7	0.39	0.01	9.6	10	0.32 [0.06;0.58]	0.02	0.0	0.81	0.00	5.3
	non-DIET/WC	2	-	-	-	-	-	-	3	-	0.64	0.0	0.75	0.00	0.6
	overall	12	0.18 [-0.09;0.45]	0.19	0.0	0.49	0.00	10.4	13	0.27 [0.04;0.49]	0.02	0.0	0.89	0.00	6.5
Sport category	combat sports	7	0.21 [-0.12;0.55]	0.21	0.0	0.94	0.00	1.8	7	0.53 [0.18;0.88]	0.00	0.0	0.91	0.00	2.1
	strength sports	3	0.72 [-0.61;2.05]	0.29	74.3	0.02	0.90	7.8	3	0.06 [-0.33;0.45]	0.77	0.0	0.93	0.00	0.2
	overall	10	0.23 [-0.07;0.52]	0.14	5.7	0.39	0.01	9.6	10	0.32 [0.06;0.58]	0.02	0.0	0.81	0.00	5.3
WL duration	]0;7] days	3	0.26 [-0.23;0.76]	0.30	0.0	0.67	0.00	0.8	4	0.51 [0.08;0.95]	0.02	0.0	0.94	0.00	0.41
	]7;14] days	1	-	-	NA	NA	NA	NA	0	NA	NA	NA	NA	NA	NA
	]14;31] days	3	0.09 [-0.51;0.68]	0.77	0.0	0.70	0.00	0.7	3	0.57 [-0.04;1.18]	0.07	0.0	0.44	0.00	1.7
	]1;3] months	2	-	-	-	-	-	-	2	-	-	-	-	-	-
	]3;6] months	1	-	-	NA	NA	NA	NA	1	-	-	NA	NA	NA	NA
	overall	10	0.23 [-0.07;0.52]	0.14	5.7	0.39	0.01	0.1	10	0.32 [0.06;0.58]	0.02	0.0	0.81	0.00	5.3
WG duration	]0;1] day	3	0.03 [-0.42;0.48]	0.89	0.0	0.97	0.00	0.1	3	0.53 [0.03;1.02]	0.04	0.0	0.85	0.00	0.33
	]1;7] days	4	0.31 [-0.1;0.71]	0.13	0.0	0.91	0.00	0.6	3	0.35 [-0.14;0.85]	0.16	0.0	0.85	0.00	0.33
	]7;14] days	2	-	-	-	-	-	-	2	-	-	-	-	-	-
	]14;31] days	1	-	-	NA	NA	NA	NA	0	NA	NA	NA	NA	NA	NA
	]1;3] months	2	-	-	-	-	-	-	2	-	-	-	-	-	-
	]3;7] months	1	-	-	NA	NA	NA	NA	1	-	-	NA	NA	NA	NA
	overall	13	0.18 [-0.06;0.42]	0.13	0.0	0.62	0.00	10.0	11	0.33 [0.08;0.58]	0.01	0.0	0.87	0.00	5.34
WG > 1 day	overall	9	0.25 [-0.08;0.59]	0.14	13.9	0.32	0.04	9.3	8	0.26 [-0.03;0.55]	0.08	0.0	0.76	0.00	4.2
WL x WG duration\$	RWL x RWG	4	0.23 [-0.17;0.64]	0.26	0.0	0.84	0.00	0.8	4	0.51 [0.08;0.95]	0.02	0.0	0.94	0.00	0.4
	RWL x LWG	1	-	-	NA	NA	NA	NA	0	NA	NA	NA	NA	NA	NA
	LWL x RWG	3	0.09 [-0.51;0.68]	0.77	0.0	0.70	0.00	0.7	3	0.57 [-0.04;1.18]	0.07	0.0	0.44	0.00	1.7
	LWL x LWG	3	0.72 [-0.61;2.05]	0.29	74.3	0.02	0.90	7.8	3	0.06 [-0.33;0.45]	0.77	0.0	0.93	0.00	0.2
	overall	11	0.22 [-0.05;0.48]	0.11	0.0	0.48	0.00	9.6	10	0.32 [0.06;0.58]	0.02	0.0	0.81	0.00	5.3

Note: Included articles were detailed per meta-analyses in Table S4. Bold: significant results; -: not reported data; \$: rapid duration was considered as a WL or a WG period of less than 14 days. Results were considered as statistically significant when $n \geq 3$ and $p < 0.05$.

Abbreviations: DIET, dieters; LWG, long weight gain; LWL, long weight loss; n, number of groups included in the meta-analyses; p, p value associated to ES; P, p value associated to I²; RWG, rapid weight gain; RWL, rapid weight loss; WC, weight cyclers; WG, weight gain; WL, weight loss.

TABLE 3 Additional results synthesis for (a) dieters' groups and (b) dieters vs. control groups.

3a		WL vs. pre-WL						WG vs. WL							
		≤ 7d	≤ 14d	≤ 1mo	≤ 3mo	≤ 6mo	> 6mo	≤ 1d	≤ 7d	≤ 14d	≤ 1mo	≤ 3mo	≤ 6mo	> 6mo	
Anthrop./BC	Hydration	↓41,67,91	NA	NA	NA	NA	NA	↑50,64,65	↑91	↑65	NA	NA	↑65,67	NA	
	BMC	=41	NA	NA	NA	NA	NA	=41	NA	NA	NA	NA	NA	NA	
	Body volume	NA	NA	NA	↑50	NA	NA	↓50	NA	NA	NA	NA	NA	NA	
	Waist circumference	NA	NA	NA	↓35[g2] =35[g1]	↓54,55	NA	NA	↑35 [g2]	NA	NA	NA	NA	NA	NA
	Total skinfolds	NA	NA	NA	↓76 =74	↓16,77	NA	NA	NA	↑74	NA	NA	NA	NA	NA
	Android fat	NA	NA	NA	NA	↓39,54	NA	NA	NA	NA	NA	NA	↓39	NA	
	Biological parameters	Insulin	↓43,57 =41	=86	NA	↓40[g1]	NA	NA	↑41,43	NA	NA	↑57	=86	NA	NA
Glucose	↓41 =38,43,71,95	=86	NA	↓40[g1]	=42	NA	↑41,43 =38,95	NA	NA	NA	=86	NA	NA		
TG	↑41,43	NA	↓88	↓40[g1]	NA	NA	=41 ↑43	NA	NA	NA	NA	NA	NA		
FFA	↑41,43	NA	↑88	↑36	NA	NA	↓41,43	NA	NA	NA	↓36	NA	NA		
HDL-c	↑41	NA	NA	↑35,36	NA	NA	↓41	NA	NA	↓35 [g2sub]	↓36	NA	NA		
LDL-c	↑41	NA	NA	NA	NA	NA	↓41	NA	NA	NA	NA	NA	NA		
Total-C	↑41	NA	NA	↑35	NA	NA	↓41	=35 [g2]	NA	NA	NA	NA	NA		
T3	↓43	↓86	NA	↓35[g1,g2] ↑35 [g2sub]	NA	NA	↑43	NA	NA	↓35 [g2sub]	NA	NA	NA		
T4	↓43	NA	NA	NA	NA	NA	↑43	NA	NA	NA	NA	NA	NA		
EE	REE	=53	=86	NA	=74,97	NA	NA	=53	NA	NA	NA	=86,97	=74	NA	
	SMR	↓40,53	NA	NA	NA	NA	NA	↑53	NA	NA	NA	NA	NA	NA	
	CHO oxidation	↓40	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Lip oxidation	=40	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Physical fitness	Heart rate	NA	NA	NA	NA	↓39	NA	NA	NA	NA	NA	NA	=39	NA	
	Anaerobic work	↓43,71 =71,103	↓34	=88,103	NA	NA	NA	↑43	↑34	NA	NA	NA	NA	NA	
	Upper limb strength	↓43 =58	↓34	=88	↓36	=39	NA	↑43	↑34	NA	=39,58	↑36	NA	NA	
	Lower limb strength	↓=95	↓34	NA	NA	=39,82	NA	=↑82,95	↑34	NA	=39	NA	NA	NA	
	Vertical jump	↓58[WCm] =58[WCf],88	↓34	=88,103	↓36	=39	NA	NA	=34	↑36	↓58[WCm]	NA	NA	NA	

TABLE 3 (Continued)

3a		WL vs. pre-WL						WG vs. WL						
		≤ 7d	≤ 14d	≤ 1mo	≤ 3mo	≤ 6mo	> 6mo	≤ 1d	≤ 7d	≤ 14d	≤ 1mo	≤ 3mo	≤ 6mo	> 6mo
	Maximal oxygen uptake	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Psycho. status	POMS - tension	↑43	NA	NA	NA	=39	NA	↑43	NA	NA	NA	NA	=39	NA
	POMS - fatigue	↑43	NA	NA	NA	=39	NA	↑43	NA	NA	NA	NA	=39	NA
	POMS - anger	↑43	NA	NA	NA	=39	NA	=43	NA	NA	NA	NA	=39	NA
	POMS - vigor	↓43	NA	NA	NA	=39	NA	↓43	NA	NA	NA	NA	=39	NA
	POMS - depression	=43	NA	NA	NA	=39	NA	↓43	NA	NA	NA	NA	=39	NA
	POMS - confusion	=43	NA	NA	NA	=39	NA	↓43	NA	NA	NA	NA	=39	NA
	TFEQ, EAT-26	NA	NA	NA	=97	NA	NA	NA	NA	NA	NA	=97	NA	NA
											=39,58 [WCf]			
3a		WG vs. pre-WL												
						RWLxRWG	RWLxLWG	LWGxRWG	LWLxLWG					
Anthrop./BC	Hydration					=41	=67	NA	NA					
	BMC					=41	NA	NA	NA					
	Body volume					NA	NA	NA	NA					
	Waist circumference					NA	NA	=35[g2]	↓54,55 =35[g2sub]					
	Total skinfolds					NA	NA	=74	=76,77					
	Android fat					NA	NA	NA	=39,54					
Biological parameters	Insulin					=41	=86	NA	NA					
	Glucose					=41,71,95↑38	=86	NA	=42					
	TG					↑41,43	=88	NA	NA					
	FFA					=41,43	=88	NA	↓36					
	HDL-c					=41	NA	NA	=35,36					
	LDL-c					=41	NA	NA	NA					
	Total-C					=41	NA	↑40[g2]	NA					
	T3					NA	NA	=35[g2]	=35[g2sub]					
T4					NA	NA	NA	NA						
EE	REE					=53	=86	NA	=74,97					
	SMR					=53	NA	NA	NA					
	CHO oxidation					↑40	NA	NA	NA					
	Lip oxidation					↑40	NA	NA	NA					

(Continues)

TABLE 3 (Continued)

		WG vs. pre-WL					
3a		RWLxRWG	RWLxLWG	LWGxRWG	LWLxLWG		
Physical fitness	Heart rate	=40	NA	NA	↓39		
	Anaerobic work	↓34,43 =37,71 ↑38	↓37	=88	NA		
	Upper limb strength	↓34,37,43	=37,58	=88	=36,39		
	Lower limb strength	=95 ↓34	NA	NA	↑39		
	Vertical jump	↓34	↓58[WCm] =58[WCf]	=88	=36,39		
	Maximal oxygen uptake	↓40 =40 ↑37	↑37	NA	NA		
	Psycho. status	POMS - tension	↑43	NA	NA	=39	
POMS - fatigue		↑43	NA	NA	=39		
POMS - anger		=43	NA	NA	=39		
POMS - vigor		↓43	NA	NA	=39		
POMS - depression		=43	NA	NA	=39		
POMS - confusion		=43	NA	NA	=39		
TFEQ, EAT-26		NA	NA	NA	=97		
		DIET vs. CT at WL			DIET vs. CT at WG		
3b		<	=	>	<	=	>
Anthropometry/Body composition	hydration	68	NA	NA	NA	NA	NA
	android fat	NA	NA	39	NA	NA	39
	waist circumference	NA	55	NA	NA	NA	NA
Biological parameters	glucose	NA	38,42	NA	NA	38,42	NA
Energy expenditure	REE	NA	86	NA	NA	85,86	NA
Physical fitness/performance	heart rate	NA	NA	39	NA	39	NA
	performance	NA	38	NA	NA	NA	NA
	upper limb strength	NA	NA	39	39	NA	NA
	lower limb strength	NA	39	NA	NA	39	NA
	vertical jump	NA	39	NA	NA	39	NA
Psychological status	TFEQ, EAT-26	NA	NA	101	NA	NA	NA

Note: (article reference [group concerned if needed]). Results are presented for the total DIET population if no group is mentioned. Case studies and studies with no apparent statistics were not considered. Abbreviations: ↑, significant increase; ↓, significant decrease; >, significantly upper; =, no significant difference; <, significantly lower; BC, body composition; BMC, bone mineral content; CHO, carbohydrates; CT, control group; d, day; DIET, dieters; EAT, eating attitudes test; EE, energy expenditure; FFA, free fatty acid; lip, lipids; LWL/G, long weight loss/gain period; mo, month; POMS, profile of moods questionnaire; REE, resting energy expenditure; RWL/G, rapid weight loss/gain period; SMR, sleeping metabolic rate; T3/T4, triiodothyronine/thyroxine hormones; TFEQ, three-factor eating questionnaire; total/HDL/LDL-C, total/high/low-density lipoprotein; total/HDL/LDL-C, total/high/low-density lipoprotein; WC, weight cyclers; WG, weight gain; WL, weight loss.

shown in Figure 4. Our results then do not seem to support the potential existence in WC athletes of the post-diet fat overshooting phenomenon put forward by Dulloo et al. in non-athletes normal-weight individuals.^{29,30} As the proposed involved mechanisms described in Figure 5, this could be explained by the fact that athletes do not limit themselves to energy restriction in their diets. Indeed, our systematic review highlights that they continue and even intensify their physical activity during the diet, also relying on other weight reduction strategies and methods. In fact, weight regulations and the methods used depend on the nature and objectives of each sport and are linked to their traditions and culture.⁵² How WL and WG are conducted—in terms of duration, amplitude, frequency, and methods used—would affect the main parameters involved in the fat overshooting phenomenon described by Dulloo et al. such as adaptive thermogenesis, kinetic body composition recovery, or compensatory behaviors that may occur during the WG phase.^{29,105,109}

4.1 | Does physical activity alleviate adaptive thermogenesis?

In the context of WL induced by energy restriction, adaptive thermogenesis consists of a reduction in cellular activity favoring a form of

“regulated” energy saving.^{106,110–112} The energy-saving metabolism (i.e., thrifty metabolism) during the WL period may persist during the recovery period, to enhance the efficiency of fat deposition during WG.¹⁰⁶ This would result in a preferential catch-up fat with FFM lagging and consequential collateral fattening (i.e., persisting hyperphagia and excess fat deposition until the complete recovery of FFM is reached), favoring fat overshooting.³¹ The maintenance of REE observed throughout WL and WG, and highlighted by our results, may partly explain the absence of fat overshooting in athletes (Table 3a).

However, while it has been shown that physical activity may prevent these cellular adaptations during WL in mice,¹⁰⁹ the potential alleviation of adaptive thermogenesis induced by physical activity remains unclear and uncertain. Indeed, some studies observed a reduction of REE following intense training periods and/or chronic energy deficiency, mainly among endurance athletes, but no WL was observed, and no post-exercise-induced energy deficit follow-up was conducted to assess longer-term effects.^{113–116}

Interestingly, data obtained among post-career athletes seem to support the potential long-term protective effect of physical activity regarding this fat overshoot. Indeed, whereas Saarni et al.¹⁰² showed a higher prevalence of overweight and obesity in WC-athletes than in other athletes, Marquet et al.¹⁰¹ did not find such a difference. This

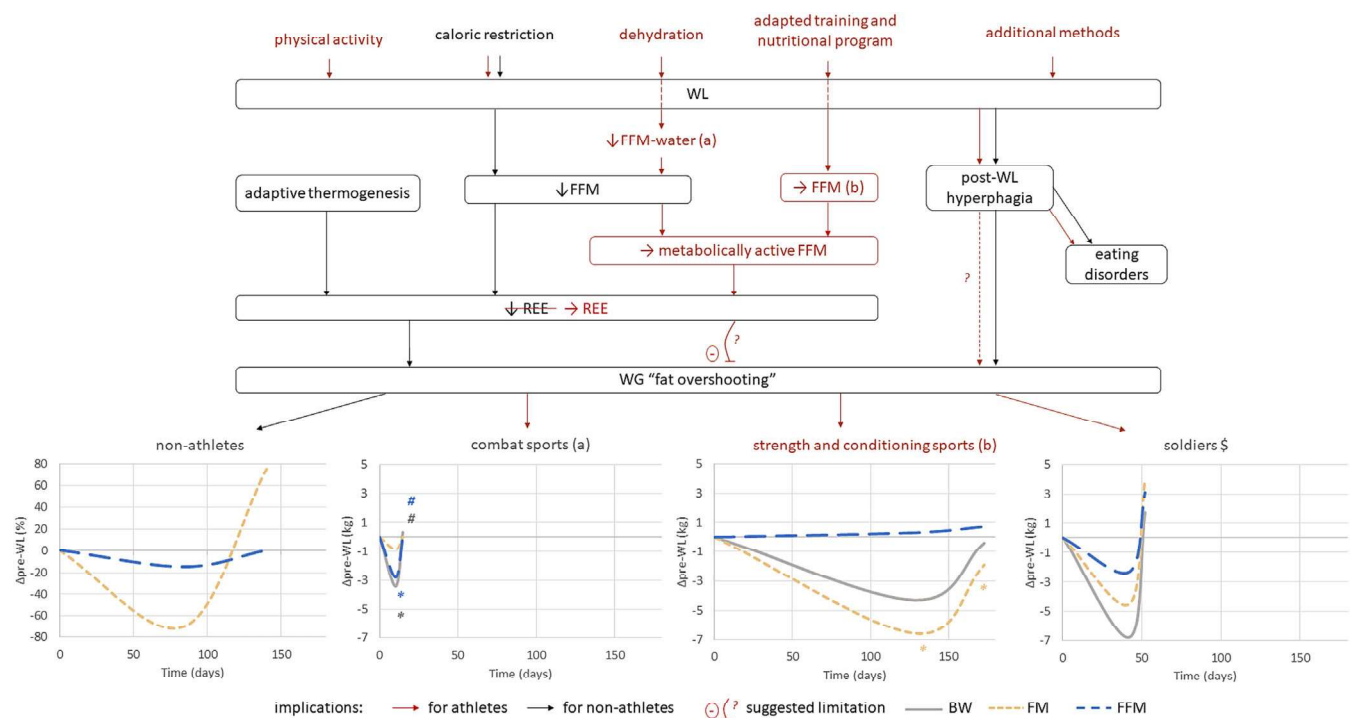


FIGURE 5 Quantification of body weight, fat mass, and fat-free mass variations and representation of potential hypothesis of the “fat overshooting” limitations among athletes. → maintenance; ↓ decrease; ? : possible effect. Presented data were subject-adjusted means calculated at WL and last WG time point measurements. Significant difference from: *: pre-WL; #: WL (meta-analyses results). \$: no meta-analyses were performed on the soldier population. (a) RWL × RWG induced by dehydration seemed to be commonly practiced in combat sports; (b) FFM maintenance seemed more common in strength and conditioning sports than in combat sports athletes. In black: implicated parameters in fat overshooting highlighted by Dulloo et al.^{29,30,105–107} and illustrated by the Minnesota Starvation Experiment¹⁰⁸, in red: possible mechanisms implicated in the “fat overshooting” limitation among athletes and soldiers highlighted in this systematic review. BW: body weight; FFM: fat-free mass, FM: fat mass, REE: resting energy expenditure, WG: weight gain, WL: weight loss.

result may be explained by the maintenance of a higher PAL in WC athletes than in other athletes in the latter study, which was not the case in the study from Saarni et al. However, the results should be considered with caution as PAL was based on self-reported subjective data in both studies.

According to Müller and Bosy-Westphal, adaptive thermogenesis seems independent of body composition.¹¹⁷ However, this conclusion is based on mild-to-modest WL rather than during substantially larger WL whose magnitude of adaptive thermogenesis is dependent on the degree of FM reductions.^{105,106,118,119}

Overall, the available evidence in athletes does not support the idea that the absence of fat overshooting resides in limitations of adaptive thermogenesis.^{113–116} It could nonetheless still reside in the dynamics of FM and FFM partitioning as discussed by Miles-Chan and Isacco.³³ Indeed, physical activity can contribute to a marginal loss (and hence preservation) of FFM.

4.2 | FFM functional tissue preservation as a limit to “collateral fat gain”

A preferential regain in FM may occur and even exceed its baseline value during the progressive restoration of the FFM and FM to their initial values (pre-WL). However, according to the present systematic review, WL strategies to maintain muscle mass seem to be privileged by some athletes, especially for strength and conditioning sports. Adjusted training programs and adapted nutritional intake on an LWL period seem to be commonly used.^{15,16,80–82,120} The possible FFM preservation during WL described by Miles-Chan and Isacco³³ appears applicable given the absence of significant difference in FFM between pre-WL versus WL (ES: 0.052, 95% CI: [−0.340; 0.444], $p = 0.794$, $I^2 = 0.0\%$). Thus, the absence of “collateral fattening” and fat overshooting is illustrated by a significantly low level of FM over time in strength and conditioning athletes.^{107,121}

Because FFM contributes up to 75% of the basal metabolic rate (BMR), it has a central role in overall energy balance.¹²² Thus, the maintenance of the FFM could also explain the maintenance of the REE observed at each phase (Table 3a).^{53,74,86,97} However, this observation was made for the overall athletes, including combat sports athletes, despite a significant reduction in FFM during the WL period (Table 2b).

In fact, athletes want to enter the lower weight category to be heavier than their opponents and have a physical advantage during the competition, added to the technical, mobility, and rapidity aspects.^{51,52} RWL is very common in combat sports and often involves the use of extreme methods such as severe dehydration.^{41,64,67,68,91} While no significant change in FM was observed, RWL through dehydration seems to favor a significant reduction in FFM in athletes (ES: −0.528, 95% CI: [−0.881; −0.175], $p = 0.003$, $I^2 = 0.0\%$). Nevertheless, it has been shown that the loss in FFM-water did not affect REE after RWL.^{112,123} The hyperhydration strategy during the post-WL recovery leads to a RWG with a return of FFM to pre-WL values. However, prolonged dehydration (up to 1 day

after weigh-in) was observed in 14–39% of MMA athletes in Matthews et al.'s and Jetton et al.'s studies, respectively.^{64,91} Moreover, 50% of wrestlers were still moderately dehydrated 3 weeks after the season in the study of Benoist et al.⁶⁵ These practices can have direct serious health repercussions in athletes such as increased resting heart rate, renal flow disturbance, heat injury, or muscle cramps.^{2,64,124} Further studies are needed to better understand the dehydration consequences in a longer post-WL period that may also be accompanied by hyperphagia.^{4,14,51}

4.3 | Side effects of compensatory hyperphagia during recovery

Although a potential return of anthropometric parameters to baseline values seems to occur during post-WL, other parameters do not appear as resilient. In fact, WL practices employed by athletes may have side effects; however, results after a recovery period remain heterogeneous regarding hormonal disturbances,^{35,41,43,57,86,88} lipid and glucose profile modifications,^{35,36,41,44,82,88} physical fitness and performance,^{34,36,37,39,43,58,71,88,95,103} mood alterations,^{15,39,43} or eating disorders.^{4,14,15,35,51,97,101} (Table 3). Indeed, while a decrease in physical fitness after WL was found in six of the included studies,^{34,36,43,56,95,100} eight did not have such results,^{39,56,58,71,88,95,100,103} which is supported by a recent meta-analysis showing that the physical performance of combat athletes does not seem to be impacted by an RWL of 5% of total BW within 7 days.¹²⁵ Interestingly, as different results were found in the same study, physical performance did not seem affected in the same way according to the type of exercise.^{71,95} Furthermore, the amount of WG seems to give an advantage over the opponent in this type of sport according to two included studies,^{2,63} which is disputed in three articles.^{59,66,76}

Importantly, hyperphagia in response to WL induced by drastic energy restriction has been shown and well documented in the Minnesota Starvation Experiment²⁹ and more recently in US Army Rangers undergoing multi-stress training.^{35,36} The binge eating observed in this study was also found in athletes participating in weight-category sports during post-WL recovery.^{4,14,15,35,51,97,101} On average, WC-athletes achieved between 1.6 and 15 WL episodes during a sports season (Table 1),^{4,99} and this succession of diets has not allowed to properly consider the potential hyperphagia consequences on WG. According to Fogelholm, dieting almost disappears in the off-season, suggesting that the eating issues usually observed during the season may be associated with performance objectives.⁷³ However, the studies included in this review found that 10.2–38.0% of athletes still “always” or “sometimes” experience binge eating during the off-season.^{4,14,15} Although the effects of hyperphagia do not seem visible on BW in the short term, several studies have shown that more than 50% of athletes practicing weight-class sports report episodes of binge eating.^{4,126,127} Interestingly, these athletes are more likely to develop eating disorders than in artistic sports (e.g., gymnastics) or in the general non-athlete population.^{128–132} However, the self-reported

nature of questionnaires limits the elaboration of a reliable diagnosis, and the results are not comparable between studies.^{128,130,131} The risk factors for the development of eating restriction and disinhibition in athletes are multifactorial, may appear unconsciously (e.g., performance, low self-esteem, pressure for being at weight, or social pressure),^{97,130,133} and need to be better considered using additional tools such as individual interviews. In addition to the presumed effects of the WC, the management of such disorders should not be neglected as they both would increase the risk of developing overweight or obesity and their associated cardiometabolic comorbidities in the long term.^{134–136} Importantly and interestingly, these WL/WG phenomena are also observed in other populations such as military soldiers. Thus, in addition to the area of sports science, we could also draw parallels between studies that have been conducted in military populations.

4.4 | FM overshooting among soldiers

As displayed in Table S2, the literature concerning military soldiers remains limited and presents a large methodological heterogeneity. However, conversely to the “being at weight” necessity observed in most sports, weight variations are a consequence rather than a goal for soldiers. Indeed, WL is a direct consequence of the imposed conditions during training camps, which combine the practice of a very intensive physical load, combined with severe energy restrictions, and often, sleep deprivation. Although, soldiers tend to regain twice the amount of FM lost.^{35,36} Side effects of such WL conditions persist 1 month after, such as binge eating or WG overshooting, but seem to go back to baseline values after a long-term recovery of 6 months.³⁵ However, due to this practice and to the side effects on mental health, soldiers appear to be predisposed to an increase in their BMI with a risk of overweight or obesity and a decline in lifespan in the longer term.^{137–140} As illustrated by our systematic approach (despite the impossibility to perform a meta-analysis), evidence remains scarce in this population despite the absolute necessity to better understand their BW and energy metabolism regulations. Further studies are then necessary during and after the soldiers' careers, considering the health consequences of their typical weight changes.

4.5 | Limitations

4.5.1 | Very-short-term WG considered by the study design

Time point measurements taken during the WG period were arbitrarily chosen by the study design and do not necessarily reflect the end of actual WG in the athletes studied. In fact, 39 studies included in this review assessed their last time point measurements (or questioned about the retrospective WG in the case of RWLQ) after a WG period of 1 week or less.^{2,3,11–13,34,38,40,41,43,44,50,53,59–64,66,68–72,78,83–85,88,90,91,94–96,98–100,103} To balance this time effect,

the duration of WL and WG was categorized as “rapid” (≤ 14 days) or “long” (> 14 days). To better consider the kinetics of weight evolution, it would have been interesting to calculate the amount of WL or WG per day.

4.5.2 | High heterogeneity among strength and conditioning athletes

No significant difference in BW was observed between each time point in strength and conditioning sports (ES: -0.456 95% CI: $[-0.997; 0.084]$, $p = 0.098$, $I^2 = 71.9\%$). The significant heterogeneity between studies for this parameter should be considered. As WL goals differ between bodybuilding and powerlifting athletes (aesthetic vs. strength), it would be interesting to discriminate results by types of sport, as the latter seeks to optimize their power-to-weight ratio as do combat sports. Only one study of weightlifters was included in this review, and no body composition measurements were considered.⁹⁶ Further studies are thus needed to investigate the physiological adaptations to weight changes for this sport.

4.5.3 | Dietary quality and nutritional impact on body composition

To understand the importance of both quantitative and qualitative energy and nutrient intake on BW, FM, and FFM evolution, a meta-analysis was considered but not conducted due to the lack of similar studies for each sport category. This would have confirmed or not the following hypotheses: (i) athletes with the highest protein intake would maintain the most FFM. This issue was addressed by Oopik et al. by supplementing his subjects with either placebo or creatine, but body composition measurements were not performed⁹⁵; (ii) athletes consuming the most dietary fat and/or carbohydrates after WL would regain the most of FM¹⁴¹; and (iii) athletes with the most severe energy restriction would have a higher probability of regaining BW, similarly to the military studies.^{34–37}

4.5.4 | What about women athletes?

Only weight-class sports were represented in this systematic review. WL is an essential part of these sports practices to optimize the power-to-weight ratio. The lack of artistic or endurance sports may be related to the inclusion criteria of this systematic review, given the young age of the population practicing these sports (i.e., artistic sports), and to the long-term low BW in those athletes by chronically reducing their energy availability (dietary EI *minus* the energy expended in exercise $< 30 \text{ kcal.kgFFM}^{-1}.\text{day}^{-1}$).^{23,142–144} This relative energy deficiency in sport (RED-S) is not without consequences for the health and performance of athletes (e.g., underweight, irregular periods or amenorrhea in female athletes, illnesses, mood changes, and injuries).^{145–147} As the majority of these sports are practiced by

female athletes, the question of the place of women in studies can be asked more broadly. Indeed, whereas they represented 45% of Olympic athletes in 2016, women represent only 10% of the subjects included in this review, and it clearly points out the importance of considering women and their specificities (body composition and hormonal status) in the studies of sport physiology.^{148–150}

4.5.5 | Methodological and statistical limitations

Although the approach used to question our main objective provides strong evidence, the multiple analyses conducted among subgroups and sub-categories have been done as exploratory and must be interpreted as such, due to a potential lack of statistical power. Moreover, despite no heterogeneity has been highlighted in pre-WL versus WG meta-analyses, a high heterogeneity between studies has been observed in some comparisons between pre-WL versus WL and WL versus WG times (Table 2). This may be related to the design of the included studies, in which WL and recovery are not performed under the same conditions, and the results are not presented and expressed in the same way (e.g., absolute or relative to pre-WL weight change data).

5 | CONCLUSION

This systematic review and meta-analysis provide an overview of the current literature about weight variations in athletes involved in weight-class sports. According to our results, WC athletes, whether their practiced sport and the methods used to achieve WL, do not seem to show extra WG in response to a WL episode (compared with pre-WL). Similar results are observed for FFM, and athletes practicing strength and conditioning sports (also having longer WL and WG periods) do not seem to fully recover their initial (pre-WL) FM. The present results then seem to suggest the potential absence in WC athletes of the fat overshooting phenomenon put forward by Dulloo et al.^{29,30} in non-athletes normal-weight individuals. Although this result might be mainly explained by the methods used by athletes to achieve WL (not only dieting), further experimental and well-controlled studies should be conducted to better understand the consequences of such WL episodes, and their repetitions, on athletes' performance as well as short and long-term physical, metabolic, and mental health.

AUTHOR CONTRIBUTIONS

David Thivel and Laurie Isacco secured the funding, conceived the article idea and design, and supervised the review. Sarah Bagot participated in the data curation, drafted, revised, and edited the manuscript. Léna Péliissier assisted in data curation. Bruno Pereira realized the formal analysis. Abdul Dulloo, Jennifer Miles-Chan, and Keyne Charlot assisted in the discussion and review of this article. Yves Boirie, Emilie Chanséaume Bussiere, and Martine Duclos reviewed the manuscript. All authors have read and approved the final version of the manuscript and agree with the order of presentation of the authors.

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CONFLICT OF INTEREST STATEMENT

No conflict of interest statement.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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Supplementary material

Weight regain, body composition, and metabolic responses to weight loss in weight cycling athletes: a systematic review and meta-analyses.

Running title: Weight regain in weight cycling athletes.

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Supplementary Table S1 Research equations used for article identification in databases.

Supplementary Table S2 Characteristics of population, study design and outcomes of studies sorted by type of sports (mean \pm SD).

Supplementary Table S3 Weight loss methods, weight gain process, and subsequent body weight and body composition evolution by type of sport in response to imposed or not weight loss and/or weight gain strategies (mean \pm SD).

Supplementary Table S4 References included per meta-analysis.

Supplementary Table S5 Additional results of interest by type of sport in response to imposed or not weight loss and/or weight gain strategies (quantitative data are given as mean \pm SD).

Supplementary Fig. S1 Relative BW, FM, and FFM evolution per WL and WG duration for **a)** combat sports, **b)** strength and conditioning sports, and **c)** soldiers.

Table S1. Research equations used for article identification in databases.

Database 1: PubMed		
Set	Search string	Results
1	("weight cycling"[TW] OR "weight cyclers"[TW] OR "weight cyclist"[TW] OR "weight cycles"[TW])	450
2	("sports"[MH] OR sport*[TW] OR "competition"[TW] OR "competitive"[TW] OR competitor*[TW] OR "athletes"[MH] OR "athletes"[TW] OR "athlete"[TW] OR "military personnel"[MH] OR "military"[TW] OR "marines"[TW] OR "armed forces"[TW] OR "soldiers"[TW] OR "soldier"[TW] OR "army"[TW] OR "ranger"[TW] OR "rangers"[TW] OR "physical conditioning, human"[MH] OR "human physical conditioning"[TW] OR "physical conditioning human"[TW] OR "human physical training"[TW] OR "martial arts"[MH] OR "kung fu"[TW] OR "gong fu"[TW] OR "fu, gong"[TW] OR "aikido"[TW] OR "judo"[TW] OR "judoka"[TW] OR "judoist"[TW] OR "judokas"[TW] OR "judoists"[TW] OR "karate"[TW] OR "arts, martial"[TW] OR "gongfu"[TW] OR "martial arts"[TW] OR "tae kwon do"[TW] OR "crossfit"[TW] OR "fitness"[Title] OR "track and field"[MH] OR "track"[Title] OR "tracks"[Title] OR "track and field"[TW] OR "field and track"[TW] OR "boxing"[MH] OR "boxer"[TW] OR "boxers"[TW] OR "running"[MH] OR "running"[Title] OR "runner"[Title] OR "runners"[Title] OR "bicycling"[MH] OR "bicycler"[TW] OR "bicyclers"[TW] OR "soccer"[MH] OR "soccers"[TW] OR "soccer"[TW] OR "football"[TW] OR "footballers"[TW] OR "footballer"[TW] OR "gymnastics"[MH] OR "gymnast"[TW] OR "gymnasts"[TW] OR "calisthenic"[TW] OR "calisthenics"[TW] OR "gymnastics"[TW] OR "weight lifting"[MH] OR "weight liftings"[TW] OR "weight training"[TW] OR "weight lifter"[TW] OR "lifting, weight"[TW] OR "wrestling"[MH] OR "wrestling"[TW] OR "wrestler"[TW] OR "wrestlers"[TW] OR "athletic performance"[MH] OR "swimming"[MH] OR "swimmer"[TW] OR "swimmers"[TW] OR "volleyball"[MH] OR "volleyballer"[TW])	666,015
3	1 AND 2	58
4	("weight loss"[MH] OR "decreased weight"[TW] OR "wt loss"[TW] OR "reduction weight"[TW] OR "reductions weight"[TW] OR "weight loss progressive"[TW] OR "weight reductions"[TW] OR "losses weight"[TW] OR "weight loss"[TW] OR "low weight"[TW] OR "weight decrease"[TW] OR "weight loss amount"[TW] OR "progressive weight loss"[TW] OR "weight reduction"[TW] OR "decreased body weight"[TW] OR "abnormal loss of weight"[TW] OR "low body weight"[TW] OR "losing wt"[TW] OR "weight decreased"[TW] OR "lost weight"[TW] OR "loss weight"[TW] OR "cachexia"[TW] OR "losing weight"[TW] OR "loss of weight"[TW] OR "weight loss finding"[TW] OR "weight losses"[TW] OR "weight decreasing"[TW] OR "mass loss"[TW] OR "decreased body mass"[TW] OR "bm loss"[TW] OR "body mass reductions"[TW] OR "body mass loss"[TW] OR "low body mass"[TW] OR "body mass decrease"[TW] OR "body mass reduction"[TW] OR "lost body mass"[TW] OR "loss body mass"[TW] OR "losing body mass"[TW] OR "body mass losses"[TW] OR "loss body mass"[TW] OR "weight gain"[MH] OR "increased body weight"[TW] OR "weight gain"[TW] OR "bw gain"[TW] OR "weight gains"[TW] OR "weight increase"[TW] OR "gains weight"[TW] OR "gain weight"[TW] OR "weight increasing"[TW] OR "wt gain"[TW] OR "weight increased"[TW] OR "gain weight"[TW] OR "body weight gain"[TW] OR "gains weight"[TW] OR "mass gain"[TW] OR "body mass gain"[TW] OR "bm gain"[TW] OR "body mass gains"[TW] OR "body mass increase"[TW] OR "gain body mass"[TW] OR "body mass increasing"[TW] OR "diet"[MH] OR "regimen"[Title] OR "regimens"[Title] OR "diet"[Title] OR "diets"[Title] OR "dietary"[Title] OR "dieting"[Title])	599,566
5	(Recovery[TW] OR Maintenance[TW] OR "weight-stable"[TW] OR "weight-variation"[TW] OR "weight-variations"[TW] OR regain[TW] OR re-gain[TW] OR "Acute weight"[TW] OR "Rapid Weight"[TW] OR "weight management"[TW] OR "changes"[TW] OR "change"[TW] OR "stable"[TW] OR "Body mass manipulation"[TW] OR "Weight cutting"[TW])	4,313,908
6	2 AND 4 AND 5	5,371
7	3 OR 6	5,394
8	((humans[Filter]) AND (english[Filter] OR french[Filter])) NOT ("systematic review"[Filter]))	16,663,876
9	7 AND 8	3,884

Database 2: Embase		
Set	Search string	Results
#1	('weight cycling'/exp OR 'weight cycling' OR 'weight cyclers' OR 'weight cyclist' OR 'weight cycles')	577
#2	('sports'/exp OR 'sports' OR sport* OR 'competition'/exp OR 'competition' OR 'competitive' OR competitor* OR 'athletes'/exp OR 'athletes' OR 'athlete'/exp OR 'athlete' OR 'military personnel'/exp OR 'military personnel' OR 'military'/exp OR 'military' OR 'marines' OR 'armed forces'/exp OR 'armed forces' OR 'soldiers'/exp OR 'soldiers' OR 'soldier'/exp OR 'soldier' OR 'army'/exp OR 'army' OR 'ranger'/exp OR 'ranger' OR 'rangers' OR 'physical conditioning, human'/exp OR 'physical conditioning, human' OR 'human physical conditioning' OR 'physical conditioning human'/exp OR 'physical conditioning human' OR 'human physical training' OR 'kung fu'/exp OR 'kung fu' OR 'gong fu' OR 'fu, gong' OR 'aikido'/exp OR 'aikido' OR 'judo'/exp OR 'judo' OR 'judoka'/exp OR 'judoka' OR 'judoist' OR 'judokas'/exp OR 'judokas' OR 'judoists' OR 'karate'/exp OR 'karate' OR 'arts, martial' OR 'gongfu' OR 'martial arts'/exp OR 'martial arts' OR 'tae kwon do'/exp OR 'tae kwon do' OR 'crossfit'/exp OR 'crossfit' OR 'track and field'/exp OR 'track and field' OR 'field and track' OR 'boxing'/exp OR 'boxing' OR 'boxer'/exp OR 'boxer' OR 'boxers'/exp OR 'boxers' OR 'bicycling'/exp OR 'bicycling' OR 'bicycler' OR 'bicyclers' OR 'soccers' OR 'soccer'/exp OR 'soccer' OR 'football'/exp OR 'football' OR 'footballers'/exp OR 'footballers' OR 'footballer'/exp OR 'footballer' OR 'gymnast'/exp OR 'gymnast' OR 'gymnasts'/exp OR 'gymnasts' OR 'calisthenic' OR 'calisthenics'/exp OR 'calisthenics' OR 'gymnastics'/exp OR 'gymnastics' OR 'weight lifting'/exp OR 'weight lifting' OR 'weight liftings' OR 'weight training'/exp OR 'weight training' OR 'weight lifter' OR 'lifting, weight'/exp OR 'lifting, weight' OR 'wrestling'/exp OR 'wrestling' OR 'wrestler' OR 'wrestler' OR 'wrestlers'/exp OR 'wrestlers' OR 'athletic performance'/exp OR 'athletic performance' OR 'swimming'/exp OR 'swimming' OR 'swimmer'/exp OR 'swimmer' OR 'swimmers' OR 'volleyball'/exp OR 'volleyball' OR 'volleyballer' OR 'fitness':ti OR 'track':ti OR 'tracks':ti OR 'running':ti OR 'runner':ti OR 'runners':ti)	1,405,002
#3	#1 AND #2	133
#4	('decreased weight' OR 'wt loss' OR 'reduction weight' OR 'reductions weight' OR 'weight loss progressive' OR 'weight reductions' OR 'losses weight' OR 'weight loss'/exp OR 'weight loss' OR 'low weight' OR 'weight decrease'/exp OR 'weight decrease' OR 'weight loss amount' OR 'progressive weight loss' OR 'weight reduction'/exp OR 'weight reduction' OR 'decreased body weight' OR 'abnormal loss of weight' OR 'low body weight'/exp OR 'low body weight' OR 'losing wt' OR 'weight decreased' OR 'lost weight' OR 'loss weight' OR 'cachexia'/exp OR 'cachexia' OR 'losing weight' OR 'loss of weight' OR 'weight loss finding' OR 'weight losses' OR 'weight decreasing' OR 'mass loss'/exp OR 'mass loss' OR 'decreased body mass' OR 'bm loss' OR 'body mass reductions' OR 'body mass loss' OR 'low body mass' OR 'body mass decrease' OR 'body mass reduction' OR 'lost body mass' OR 'losing body mass' OR 'body mass losses' OR 'loss body mass' OR 'increased body weight' OR 'weight gain'/exp OR 'weight gain' OR 'bw gain' OR 'weight gains' OR 'weight increase'/exp OR 'weight increase' OR 'weight increasing' OR 'wt gain' OR 'weight increased' OR 'gain weight' OR 'body weight gain'/exp OR 'body weight gain' OR 'gains weight' OR 'mass gain' OR 'body mass gain' OR 'bm gain' OR 'body mass gains' OR 'body mass increase' OR 'gain body mass' OR 'body mass increasing' OR 'diet'/exp OR 'diet':ti OR 'regimen':ti OR 'regimens':ti OR 'diets':ti OR 'dietary':ti OR 'dieting':ti)	889,929
#5	('recovery'/exp OR recovery OR 'maintenance'/exp OR maintenance OR 'weight-stable' OR regain OR 're gain' OR 'acute weight' OR 'rapid weight' OR 'weight-variation' OR 'weight variations' OR 'weight management'/exp OR 'weight management' OR 'changes' OR 'change'/exp OR 'change' OR 'stable' OR 'body mass manipulation' OR 'weight cutting'/exp OR 'weight cutting')	8,878,169
#6	#2 AND #4 AND #5	24,272
#7	#3 OR #6	24,323
#8	'human'/de AND ('article'/it OR 'article in press'/it) AND [embase]/lim NOT ([embase]/lim AND [medline]/lim) AND ([english]/lim OR [french]/lim)	1,520,350
#9	#7 AND #8	1,509

Database 3: SPORTDiscus		
Set	Search string	Results
S1	AB (("weight cycling" OR "weight cyclers" OR "weight cyclist" OR "weight cycles")) OR TI (("weight cycling" OR "weight cyclers" OR "weight cyclist" OR "weight cycles")) OR SU (("weight cycling" OR "weight cyclers" OR "weight cyclist" OR "weight cycles"))	88
S2	AB ("sports" OR sport* OR "competition" OR "competitive" OR competitor* OR "athletes" OR "athletes" OR "athlete" OR "military personnel" OR "military" OR "marines" OR "armed forces" OR "soldiers" OR "soldier" OR "army" OR "ranger" OR "rangers" OR "physical conditioning, human" OR "human physical conditioning" OR "physical conditioning human" OR "human physical training" OR "martial arts" OR "kung fu" OR "gong fu" OR "fu, gong" OR "aikido" OR "judo" OR "judoka" OR "judoist" OR "judokas" OR "judoists" OR "karate" OR "arts, martial" OR "gongfu" OR "martial arts" OR "tae kwon do" OR "crossfit" OR "track and field" OR "track and field" OR "field and track" OR "boxing" OR "boxer" OR "boxers" OR "bicycling" OR "bicycler" OR "bicyclers" OR "soccer" OR "soccers" OR "soccer" OR "football" OR "footballers" OR "footballer" OR "gymnastics" OR "gymnast" OR "gymnasts" OR "calisthenic" OR "calisthenics" OR "gymnastics" OR "weight lifting" OR "weight liftings" OR "weight training" OR "weight lifter" OR "lifting, weight" OR "wrestling" OR "wrestling" OR "wrestler" OR "wrestlers" OR "athletic performance" OR "swimming" OR "swimmer" OR "swimmers" OR "volleyball" OR "volleyballer") OR TI ("sports" OR sport* OR "competition" OR "competitive" OR competitor* OR "athletes" OR "athletes" OR "athlete" OR "military personnel" OR "military" OR "marines" OR "armed forces" OR "soldiers" OR "soldier" OR "army" OR "ranger" OR "rangers" OR "physical conditioning, human" OR "human physical conditioning" OR "physical conditioning human" OR "human physical training" OR "martial arts" OR "kung fu" OR "gong fu" OR "fu, gong" OR "aikido" OR "judo" OR "judoka" OR "judoist" OR "judokas" OR "judoists" OR "karate" OR "arts, martial" OR "gongfu" OR "martial arts" OR "tae kwon do" OR "crossfit" OR "track and field" OR "track and field" OR "field and track" OR "boxing" OR "boxer" OR "boxers" OR "bicycling" OR "bicycler" OR "bicyclers" OR "soccer" OR "soccers" OR "soccer" OR "football" OR "footballers" OR "footballer" OR "gymnastics" OR "gymnast" OR "gymnasts" OR "calisthenic" OR "calisthenics" OR "gymnastics" OR "weight lifting" OR "weight liftings" OR "weight training" OR "weight lifter" OR "lifting, weight" OR "wrestling" OR "wrestling" OR "wrestler" OR "wrestlers" OR "athletic performance" OR "swimming" OR "swimmer" OR "swimmers" OR "volleyball" OR "volleyballer" OR "fitness" OR "track" OR "tracks" OR "running" OR "runner" OR "runners") OR SU ("sports" OR sport* OR "competition" OR "competitive" OR competitor* OR "athletes" OR "athletes" OR "athlete" OR "military personnel" OR "military" OR "marines" OR "armed forces" OR "soldiers" OR "soldier" OR "army" OR "ranger" OR "rangers" OR "physical conditioning, human" OR "human physical conditioning" OR "physical conditioning human" OR "human physical training" OR "martial arts" OR "kung fu" OR "gong fu" OR "fu, gong" OR "aikido" OR "judo" OR "judoka" OR "judoist" OR "judokas" OR "judoists" OR "karate" OR "arts, martial" OR "gongfu" OR "martial arts" OR "tae kwon do" OR "crossfit" OR "track and field" OR "track and field" OR "field and track" OR "boxing" OR "boxer" OR "boxers" OR "bicycling" OR "bicycler" OR "bicyclers" OR "soccer" OR "soccers" OR "soccer" OR "football" OR "footballers" OR "footballer" OR "gymnastics" OR "gymnast" OR "gymnasts" OR "calisthenic" OR "calisthenics" OR "gymnastics" OR "weight lifting" OR "weight liftings" OR "weight training" OR "weight lifter" OR "lifting, weight" OR "wrestling" OR "wrestling" OR "wrestler" OR "wrestlers" OR "athletic performance" OR "swimming" OR "swimmer" OR "swimmers" OR "volleyball" OR "volleyballer")	1,027,210
S3	S1 AND S2	45
S4	AB ("weight loss" OR "decreased weight" OR "wt loss" OR "reduction weight" OR "reductions weight" OR "weight loss progressive" OR "weight reductions" OR "losses weight" OR "weight loss" OR "low weight" OR "weight decrease" OR "weight loss amount" OR "progressive weight loss" OR "weight reduction" OR "decreased body weight" OR "abnormal loss of weight" OR "low body weight" OR "losing wt" OR "weight decreased" OR "lost weight" OR "loss weight" OR "cachexia" OR "losing weight" OR "loss of weight" OR "weight loss finding" OR "weight losses" OR "weight decreasing" OR "mass loss" OR "decreased body mass" OR "bm loss" OR "body mass reductions" OR "body mass loss" OR "low body mass" OR "body mass decrease" OR "body mass reduction" OR "lost body mass" OR "loss body mass" OR "losing body mass" OR "body mass losses" OR "loss body mass" OR "weight gain" OR "increased body weight" OR "weight gain" OR "bw gain" OR "weight gains" OR "weight increase" OR "gains weight" OR "gain weight" OR "weight increasing" OR "wt gain" OR "weight increased" OR "gain weight" OR "body weight gain" OR "gains weight" OR "mass gain" OR "body mass gain" OR "bm gain" OR "body mass gains"	44,963

	OR "body mass increase" OR "gain body mass" OR "body mass increasing") OR TI ("weight loss" OR "decreased weight" OR "wt loss" OR "reduction weight" OR "reductions weight" OR "weight loss progressive" OR "weight reductions" OR "losses weight" OR "weight loss" OR "low weight" OR "weight decrease" OR "weight loss amount" OR "progressive weight loss" OR "weight reduction" OR "decreased body weight" OR "abnormal loss of weight" OR "low body weight" OR "losing wt" OR "weight decreased" OR "lost weight" OR "loss weight" OR "cachexia" OR "losing weight" OR "loss of weight" OR "weight loss finding" OR "weight losses" OR "weight decreasing" OR "mass loss" OR "decreased body mass" OR "bm loss" OR "body mass reductions" OR "body mass loss" OR "low body mass" OR "body mass decrease" OR "body mass reduction" OR "lost body mass" OR "loss body mass" OR "losing body mass" OR "body mass losses" OR "loss body mass" OR "weight gain" OR "increased body weight" OR "weight gain" OR "bw gain" OR "weight gains" OR "weight increase" OR "gains weight" OR "gain weight" OR "weight increasing" OR "wt gain" OR "weight increased" OR "gain weight" OR "body weight gain" OR "gains weight" OR "mass gain" OR "body mass gain" OR "bm gain" OR "body mass gains" OR "body mass increase" OR "gain body mass" OR "body mass increasing" OR OR "regimen" OR "regimens" OR "diet" OR "diets" OR "dietary" OR "dieting") OR SU ("weight loss" OR "decreased weight" OR "wt loss" OR "reduction weight" OR "reductions weight" OR "weight loss progressive" OR "weight reductions" OR "losses weight" OR "weight loss" OR "low weight" OR "weight decrease" OR "weight loss amount" OR "progressive weight loss" OR "weight reduction" OR "decreased body weight" OR "abnormal loss of weight" OR "low body weight" OR "losing wt" OR "weight decreased" OR "lost weight" OR "loss weight" OR "cachexia" OR "losing weight" OR "loss of weight" OR "weight loss finding" OR "weight losses" OR "weight decreasing" OR "mass loss" OR "decreased body mass" OR "bm loss" OR "body mass reductions" OR "body mass loss" OR "low body mass" OR "body mass decrease" OR "body mass reduction" OR "lost body mass" OR "loss body mass" OR "losing body mass" OR "body mass losses" OR "loss body mass" OR "weight gain" OR "increased body weight" OR "weight gain" OR "bw gain" OR "weight gains" OR "weight increase" OR "gains weight" OR "gain weight" OR "weight increasing" OR "wt gain" OR "weight increased" OR "gain weight" OR "body weight gain" OR "gains weight" OR "mass gain" OR "body mass gain" OR "bm gain" OR "body mass gains" OR "body mass increase" OR "gain body mass" OR "body mass increasing" OR " diet")	
S5	AB (Recovery OR Maintenance OR "weight variation" OR "weight variations" OR "weight-stable" OR regain OR re-gain OR "Acute weight" OR "Rapid Weight" OR "weight management" OR "changes" OR "change" OR "stable" OR "Body mass manipulation" OR "Weight cutting") OR TI (Recovery OR Maintenance OR "weight variation" OR "weight variations" OR "weight-stable" OR regain OR re-gain OR "Acute weight" OR "Rapid Weight" OR "weight management" OR "changes" OR "change" OR "stable" OR "Body mass manipulation" OR "Weight cutting") OR SU (Recovery OR Maintenance OR "weight variation" OR "weight variations" OR "weight-stable" OR regain OR re-gain OR "Acute weight" OR "Rapid Weight" OR "weight management" OR "changes" OR "change" OR "stable" OR "Body mass manipulation" OR "Weight cutting")	201,610
S6	S2 AND S4 AND S5	1,684
S7	S3 OR S6	1,684
S8	Filters: ("Revues universitaires" AND ("English" OR "French"))	800,259
S9	S7 AND S8	1,176

Table S2. Characteristics of population, study design and outcomes of studies sorted by type of sports (mean ± SD).

Reference	Population characteristics (sport, n (male + female), age; BMI or BW and height)	Study design [follow-up]	Outcomes (method)
		Time points	
Combat sports			
Usual athletes' methods of WL and WG (not imposed by the study design)			
Amatori, 2020 83 (Italy)	Boxing: n = 164, 22.9 ± 6.4 y; 68.9 ± 12.2 kg; 174.5 ± 8.1 cm m: n = 144, 23.4 ± 6.4 y; 70.7 ± 11.8 kg; 175.9 ± 7.1 cm f: n = 20, 19.2 ± 5.5 y; 56.1 ± 6.1 kg; 164.2 ± 7.4 cm cluster 1 (C1, severe WL behaviours): n = 133, 23 ± 6.3 y; 68.5 ± 11.0 kg; NR - C1 m: n = 120, 22.9 ± 6.2 y; 70.0 ± 10.5 kg; NR - C1 f: n = 13, 19.1 ± 6.0 y; 56.2 ± 6.6 kg; NR cluster 2 (C2, light WL behaviours): n = 31, 24.6 ± 7.0 y; 70.8 ± 17.0 kg; NR - C2 m: n = 24, 25.9 ± 7.1 y; 74.7 ± 16.9 kg; NR - C2 f: n = 7, 19.7 ± 4.6 y; 55.9 ± 5.2 kg; NR	Transversal, Observational, Retrospective [N/A] <u>pre-WL:</u> current weight <u>WL:</u> habitual WL duration <u>WG:</u> 7 d (post-competition)	<u>Weight management:</u> RWLQ
Daniele, 2016 59 (Worldwide)	Boxing: n = 142 (126m + 16f), 28.5 ± 5.1 y; NR	Transversal, Observational [12 h] <u>WL:</u> weigh-in <u>WG:</u> 12 h	<u>Anthropometry/Body composition:</u> BW; WG; weight difference between fighters (WD) <u>Physical fitness/performance:</u> performance (fight issue in competition)
Dugonjić, 2019 84 (Europe)	Boxing (kickboxing): n = 61 (m), 24.2 ± 4.6 y; 22.9 ± 2.6 kg/m ² LW: n = 16 MW: n = 25 HW: n = 20	Transversal, Observational, Retrospective [N/A] <u>pre-WL:</u> current weight <u>WL:</u> habitual WL duration <u>WG:</u> 7 d (post-competition)	<u>Weight management:</u> RWLQ
Morehen, 2021 78 (USA)	Boxing: n = 1 (m), 32 y; 88.6 ± 2.1 kg; NR	Longitudinal, Observational, Case study [5 y] 11 training camps (T1 - T11) of 11 ± 4 wk During an official competition week (T11): <u>pre-WL:</u> baseline (pre-camp) <u>WL:</u> daily measure (WL-1 to WL-8 (weigh-in)) <u>WG-1:</u> post weigh-in + <u>WG-2:</u> prefight	<u>Anthropometry/Body composition:</u> BW; FM, FFM (DXA) <u>Energy intake, dietary and eating behaviours:</u> food intake (1-wk food record at T11 and before one combat) <u>Physical activity:</u> training program (exercise training record) <u>Energy expenditure:</u> REE (indirect calorimetry)
Murugappan, 2021a 60 (USA)	Boxing: n = 399 (m), NR; NR (no HW category)	Transversal, Observational, Retrospective [32 h] <u>WL:</u> weigh-in <u>WG:</u> 26 - 32 h	<u>Anthropometry/Body composition:</u> BW
Reale, 2017 62 (Australia)	Boxing: n = 100 (70m + 30f), NR; NR	Longitudinal, Observational [5 d] <u>WL-1:</u> 1 - 5 d pre-match + <u>WL-2:</u> 4 - 13 h pre-match (weigh-in) <u>WG:</u> 1 h pre-match	<u>Anthropometry/Body composition:</u> BW <u>Weight management:</u> self-reported survey
Reljic, 2015 85 (USA)	Boxing: n = 17 (m) DIET: n = 10, 19.7 ± 3.2 y; 67.4 ± 9.4 kg; 175.5 ± 7.0 cm non-DIET (CT): n = 7, 18.4 ± 2.2 y; 64.8 ± 8.9 kg; 174.6 ± 7.4 cm	Longitudinal, Observational, Controlled [3 wk] <u>pre-WL:</u> baseline (during weight maintenance) <u>WL:</u> 7 d (2 d pre-competition) <u>WG:</u> 5 d (7 d post-competition)	<u>Anthropometry/Body composition:</u> BW; height; FM, FFM (skinfolds) <u>Energy intake, dietary and eating behaviours:</u> food intake (7-d food record) <u>Physical activity:</u> PAL <u>Biological parameters:</u> vitamins (fasting blood samples) <u>Energy expenditure:</u> TEE (activity diary); REE (indirect calorimetry)

Reference	Population characteristics (sport, n (male + female), age; BMI or BW and height)	Study design [follow-up] Time points	Outcomes (method)
White, 2021 99 (England)	BJJ: n = 115 (108m + 7f) WC: n = 68, 27.9 ± 6.3 y; 78.9 ± 9.3 kg; NR non-WC: n = 47	Transversal, Observational, Retrospective [N/A] <u>pre-WL:</u> current weight <u>WL:</u> habitual WL duration <u>WG:</u> 7 d (post-competition)	<u>Weight management:</u> RWLQ
Artioli, 2010a 38 (Brazil)	Judo: n = 14 (m) WC: n = 7, 20 ± 4 y; 77.9 ± 12.2 kg; 175 ± 6 cm - WC subgroup (WCsub): n = 4, NR; 72.56 ± 7.99 kg; 174.38 ± 2.87 cm non-WC (CT): n = 7, 22 ± 4 y; 67.3 ± 5.8 kg; 170 ± 6 cm	Longitudinal, Observational, Controlled [5 d] <u>pre-WL:</u> baseline <u>WL:</u> 5 d <u>WG:</u> 4 h	<u>Anthropometry/Body composition:</u> BW; FFM, FM, residual volume (underwater weighing) <u>Energy intake, dietary and eating behaviours:</u> food intake (3-d food record) <u>Biological parameters:</u> glucose, lactate, red blood cells (fasting blood sample) <u>Physical fitness/performance:</u> performance (fight issue and judo related performance in simulated competition); power and anaerobic work capacity (Wingate 30-s bicycle)
Artioli, 2010b 12 (Brazil)	Judo: n = 822 (607m + 215f), 19.3 ± 5.3 y; 70 ± 17.5 kg; 170.6 ± 9.8 cm HW: n = 49 non-HW: n = 773 - WC: n = 688	Transversal, Observational, Retrospective [N/A] <u>pre-WL:</u> current weight <u>WL:</u> habitual WL duration <u>WG:</u> 7 d (post-competition)	<u>Weight management:</u> RWLQ
Brewer, 1992 86 (Canada)	Judo: n = 18 (m) WC: n = 9, 25 ± 7.8 y; 81.8 ± 12.3 kg; 175 ± 6.9 cm non-WC (CT): n = 9, 25 ± 4.5 y; 85.1 ± 12.4 kg; 182 ± 12.6 cm	Longitudinal, Observational, Controlled [10 mo] <u>pre-WL:</u> pre-season <u>WL-1:</u> peak season (1 wk pre-competition) + <u>WL-2:</u> 1 wk (competition weigh-in) <u>WG:</u> off-season (3 mo post-competition)	<u>Anthropometry/Body composition:</u> BW; FM, FFM (skinfolds); body density; waist and hips circumferences <u>Energy intake, dietary and eating behaviours:</u> food intake (3-d food record) <u>Biological parameters:</u> T3, insulin, glucose (fasting blood sample) <u>Energy expenditure:</u> REE (fasting indirect calorimetry, Weir's equation)
Kowatari, 2001 87 (Japan)	Judo: n = 18 (m), 18 - 21 y; NR DIET: n = 12 - low energy intake (LEI): n = 6, NR; 74.7 ± 5.6 kg; NR - very low energy intake (VLEI): n = 6, NR; 74.3 ± 6.2 kg; NR non-DIET (CT): n = 6, NR; 75.0 ± 5.7 kg; NR	Longitudinal, Observational, Controlled [27 d] <u>pre-WL:</u> baseline <u>WL-1:</u> 15 d + <u>WL-2:</u> 4 d (1 d pre-competition) <u>WG:</u> 8 d (7 d post-competition)	<u>Anthropometry/Body composition:</u> BW; FM, FFM, residual lung volume (underwater weighing) <u>Energy intake, dietary and eating behaviours:</u> food intake (food weight and composition table) <u>Physical activity:</u> training program <u>Biological parameters:</u> blood leukocyte, neutrophil, lymphocyte, neutrophil oxidative burst / phagocytosis assays (fasting blood sample)
Ohta, 2002 88 (Japan)	Judo: n = 10 (m), 20.0 ± 0.9 y; 73.9 ± 11.1 kg; 169.4 ± 4.2 cm slight WL: n = 5 marked WL: n = 5	Longitudinal, Observational [25 d] <u>pre-WL:</u> baseline <u>WL-1:</u> 13 d (7 d pre-competition) + <u>WL-2:</u> 6 d (1 d pre-competition) <u>WG:</u> 5 d (post-competition)	<u>Anthropometry/Body composition:</u> BW; FM, FFM (underwater weighing) <u>Energy intake, dietary and eating behaviours:</u> food intake (daily food record) <u>Biological parameters:</u> leukocyte count, haematocrit, total protein, TG, FFA, creatine kinase, immunoglobulins, complements, C-reactive protein (fasting blood sample); Serum Opsonic Activity (blood sample) <u>Energy intake, dietary and eating behaviours:</u> food intake (daily food record) <u>Physical fitness/performance:</u> lower limb explosiveness (vertical jump); muscle strength (grip, dorsal back strength, isometric elbow flexor strength); power and anaerobic work capacity (bicycle ergometer 40-s)
Prouteau, 2006a 56 ► (France)	total: n = 68 Judo: n = 48 judo m: n = 22, 20.9 ± 3.4 y; 24 ± 2.1 kg/m ² judo f: n = 26, 19 ± 2.4 y; 22.7 ± 2.4 kg/m ² WC: n = 19 (9m + 10f) non-WC (CT): n = 29 (13m + 16f) <u>Active students (AS):</u> n = 20 AS m: n = 8, 20.1 ± 1.0 y; 23 ± 3.1 kg/m ² AS f: n = 12, 19.5 ± 0.9 y; 21.3 ± 1.9 kg/m ²	Longitudinal, Observational, Controlled [7 mo] <u>pre-WL:</u> baseline (early season) <u>WL:</u> 7 d (24h pre-competition) <u>WG:</u> 3 wk (post-competition)	<u>Anthropometry/Body composition:</u> BW; height; FM, FFM, total and regional BMC and BMD (DXA) <u>Weight management:</u> weight cycling (interview + medical records) <u>Energy intake, dietary and eating behaviours:</u> food intake (7-d food record at pre-WL) <u>Physical activity:</u> training program (interview + medical records + training diary) <u>Biological parameters:</u> CTx, osteocalcin, cortisol, total protein (blood samples); menstrual status (interview)
Prouteau, 2006b 57 ► (France)	Judo: n = 48, 20 ± 3.0 y; NR m: n = 22, 20.9 ± 3.4 y; 24 ± 2.1 kg/m ² f: n = 26, 19 ± 2.4 y; 22.7 ± 2.4 kg/m ² WC: n = 19 non-WC (CT): n = 29	Longitudinal, Observational [6 mo] <u>pre-WL:</u> baseline (early season, October) <u>WL (7 d of food restriction):</u> <u>WL-1:</u> 6 d + <u>WL-2:</u> 24 h (pre-competition) <u>WG:</u> 3 wk (post-competition)	<u>Anthropometry/Body composition:</u> BW; FM, FFM, total and regional BMC and BMD (DXA) <u>Weight management:</u> weight cycling (interview + medical records) <u>Energy intake, dietary and eating behaviours:</u> food intake (7-d food record at pre-WL) <u>Physical activity:</u> training program (interview + medical records + training diary) <u>Biological parameters:</u> CTx, osteocalcin, leptin, insulin, cortisol, total plasma proteins (blood sample); menstrual status (interview)

Reference	Population characteristics (sport, n (male + female), age; BMI or BW and height)	Study design [follow-up] Time points	Outcomes (method)
Prouteau, 2007 58 ▶ (France)	Judo: n = 48 m: n = 22, 21 ± 3 y; 24 ± 2.1 kg/m ² f: n = 26, 19 ± 2 y; 22.6 ± 2.4 kg/m ² WC: n = 19 - WC m: n = 9, NR; 77.7 ± 8.2 kg*; NR - WC f: n = 10 non-WC (CT): n = 29 - non-WC m: n = 13, NR; 70.7 ± 7.6 kg*; NR - non-WC f: n = 16	Longitudinal, Observational [6 mo] pre-WL: baseline (early season, October) WL: 7 d (March, 24h pre-competition) WG: 3 wk (post-competition)	Anthropometry/Body composition: BW; FM, FFM, total and regional BMC and BMD (DXA) Weight management: WL methods (interview + medical records) Energy intake, dietary and eating behaviours: food intake (7-d food record at pre-WL) Physical activity: training program (interview + medical records + training diary) Biological parameters: CTx, osteocalcin, leptin, insulin, cortisol, total plasma proteins (blood sample); menstrual status (interview) Physical fitness/performance: lower limb explosiveness (vertical jump Sargent test); muscle strength (hand grip)
Reale, 2016 63 (Australia)	Judo: n = 86 (50m + 36f), NR; NR winners: n = 44 losers: n = 46 (no HW category)	Transversal, Observational [3 d] WL: weigh-in WG: 15 - 20 h (1h pre-fight)	Anthropometry/Body composition: BW Physical fitness/performance: performance (fight issue in competition)
Suzuki, 2003 89 (Japan)	Judo: n = 16 (f) DIET: n = 8, NR; 65.5 ± 12.0 kg; NR non-DIET (CT): n = 8, NR; 64.8 ± 8.4 kg; NR	Longitudinal, Observational, Controlled [28 d] pre-WL: baseline WL: 20 d (1 d pre-competition) WG: 8 d (7 d post-competition)	Anthropometry/Body composition: BW Energy intake, dietary and eating behaviours: food intake (3-d food record) Biological parameters: blood leukocyte, neutrophil and lymphocytes count, neutrophil oxidative burst and phagocytosis (blood samples)
Connor, 2019 90 (Ireland)	MMA: n = 30 (m), 25.5 ± 4.4 y; 24.3 ± 2.1 kg/m ² WC: n = 29 HW: n = 1	Transversal, Observational, Retrospective [N/A] pre-WL: current BW WL: habitual WL duration WG: 7 d (post-competition)	Weight management: RWLQ
Coswig, 2019 2 (Brazil)	MMA: n = 15 (m); 25.4 ± 6.1 y; 89.9 ± 17.3 kg; 173.9 ± 0.2 cm winners: n = 8 losers: n = 7	Longitudinal, Observational [1 mo] pre-WL: baseline WL: 15 to 30 d (weigh-in) WG: 24 h	Anthropometry/Body composition: BW Weight management: RWLQ Energy intake, dietary and eating behaviours: food intake (24-h food record) Physical fitness/performance: performance (fights' video time-motion analysis) Psychological status: POMS
Jetton, 2013 64 (USA)	MMA: n = 40 (38m + 2f), 25.2 ± 0.7 y; NR; 177 ± 1 cm	Transversal, Observational [1 d] WL: weigh-in WG: 22 h (2 h pre-competition)	Anthropometry/Body composition: BW; height; FM (skinfold); hydration (USG, urine sample)
Kasper, 2019 79 (England)	MMA: n = 1 (m), 22 y; 80.2 kg; 180 cm	Longitudinal, Observational, Case study [10 wk] pre-WL: baseline WL-1: 4 wk + WL-2: 3 wk training camp: energy restriction WL-3: 2 d + WL-4: 1 d + WL-5: 1 d + WL-6: 1 d + WL-7: 1 d training camp: water loading WL-8: 1 d (weigh-in) acute WL WG-1: 1 d rehydration and refuel strategy WG-2: 2 wk ad libitum recovery	Anthropometry/Body composition: BW; height; FM, FFM (DXA + skinfolds) Energy intake, dietary and eating behaviors: food intake ("estimation of the meal preparation company") Physical activity: training program (exercise training record) Biological parameters: testosterone, cortisol, IGF-1, LH, FSH, SHBG, TG, total-C, HDL-C, LDL-C, urea, creatinine, albumin, total protein, chloride, bicarbonate, sodium, osmolality (blood samples) Energy expenditure: REE (indirect calorimetry) Physical fitness/performance: maximal oxygen uptake (treadmill test)
Matthews, 2017 91 (UK)	MMA: n = 7 (m), 24.6 ± 3.5 y; 69.9 ± 5.7 kg; NR	Longitudinal, Observational, Retrospective [1 wk] pre-WL: baseline WL: 5 d (weigh-in) WG: 32 h	Anthropometry/Body composition: BW; hydration (UOSM, urine sample) Weight management: RWLQ Energy intake, dietary and eating behaviours: food intake (7-d food record)

Reference	Population characteristics (sport, n (male + female), age; BMI or BW and height)	Study design [follow-up] Time points	Outcomes (method)
Murugappan, 2021b 61 (USA)	MMA: n = 512 (455m + 57f), NR; NR	Transversal, Observational [1 d] <u>WL:</u> weigh-in <u>WG:</u> 1 d (competition day)	<u>Anthropometry/Body composition:</u> BW
Drid, 2021 3 (Worldwide)	Sambo: n = 199 m: n = 132, 23.16 ± 6.08 y; 75.22 ± 17.78 kg; 175 ± 10 cm f: n = 67, 21.70 ± 5.22 y; 64.58 ± 14.90 kg; 164 ± 9 cm WC: n = 173 non-WC: n = 26	Transversal, Observational, Retrospective [N/A] <u>pre-WL:</u> current weight <u>WL:</u> habitual WL duration <u>WG:</u> 7 d (post-competition)	<u>Weight management:</u> RWLQ
Figlioli, 2021 13 (USA)	Sambo: n = 103 (m) seniors: n = 57, 28.5 ± 4.3 y; 25.0 ± 3.8 kg/m ² juniors: n = 46, 18.9 ± 0.8 y; 23.7 ± 3.9 kg/m ²	Transversal, Observational, Retrospective [N/A] <u>pre-WL:</u> current weight <u>WL:</u> habitual WL duration <u>WG:</u> 7 d (post-competition)	<u>Weight management:</u> RWLQ
da Silva Santos, 2016 11 (Brazil)	TKD: n = 116 (72m + 44f) regional level (R): n = 40 - R m: n = 31, 21.6 ± 5.8 y; 69.2 ± 14.9 kg*; 176.6 ± 8.3 cm# - R f: n = 9, 23.9 ± 5.9 y; 59.6 ± 8.6 kg*; 162.7 ± 7.9 cm# - R WC: n = 32 (24m + 8f) national/international level (N/IN): n = 76 - N/IN m: n = 41, 22.3 ± 5.5 y*; 70.5 ± 15.1 kg*; 176.6 ± 8.3 cm# - N/IN f: n = 35, 19.8 ± 4.2 y*; 54.8 ± 9.1 kg*; 163.3 ± 6.9 cm# - N/IN WC: n = 62 (31m + 31f)	Transversal, Observational, Retrospective [N/A] <u>pre-WL:</u> current weight <u>WL:</u> habitual WL duration <u>WG:</u> 7 d (post-competition)	<u>Weight management:</u> RWLQ
Tsai, 2011 92 (Taiwan)	TKD: n = 16 (m), 21.6 ± 1.3 y; 23.5 ± 3.1 kg/m ²	Longitudinal, Observational [49 d] <u>pre-WL:</u> baseline (30 d pre-competition) <u>WL</u> (training camp): <u>WL-1:</u> 7 d (14 d pre-competition) + <u>WL-2:</u> 6 d (7 d pre-competition) + <u>WL-3:</u> 1 d (1 d pre-competition) <u>WG</u> (training camp): <u>WG-1:</u> 1 d + <u>WG-2:</u> 7 d + <u>WG-3:</u> 19 d	<u>Anthropometry/Body composition:</u> BW; height; BMI; FM (bioimpedance) <u>Physical activity:</u> training program <u>Biological parameters:</u> upper respiratory tract infections (health checklist); total protein, lactoferrin, IgA, cortisol (saliva sample)
Benoist, 2014 65 (USA)	Wrestling: n = 8 (m), 20.5 ± 1.3 y; 73.7 ± 9.9 kg; 180.7 ± 6.0 cm	Longitudinal, Observational [NR] <u>WL:</u> baseline (prior to the match) <u>WG-1:</u> 20h (post-match) + <u>WG-2:</u> 1 wk + <u>WG-3:</u> 3 wk post-season	<u>Anthropometry/Body composition:</u> BW; hydration (USG, urine sample)
Horswill, 1994 66 (USA)	Wrestling: n = 607 (m), NR; NR HW: n = 72 non-HW: n = 535 - winners: n = 266 - losers: n = 269	Transversal, Observational [1 d] <u>WL:</u> weigh-in <u>WG:</u> 19h (1h pre-competition)	<u>Anthropometry/Body composition:</u> BW <u>Physical fitness/performance:</u> performance (self-reported seasonal fight issue in competition)
Kukidome, 2008 93 (Japan)	Wrestling: n = 12 (m), 20.3 ± 0.9 y; 74.5 ± 9.2 kg; 170.0 ± 4.6 cm	Longitudinal, Observational [6 wk] <u>pre-WL:</u> baseline <u>WL-1:</u> 3 wk + <u>WL-2:</u> 1 wk (weigh-in) <u>WG-1:</u> after the match + <u>WG-2:</u> 1 wk after the match	<u>Anthropometry/Body composition:</u> BW; FM, FFM, TBW (bioimpedance); muscle and subcutaneous fat in the femoral and trunk CSA (MRI) <u>Energy intake, dietary and eating behaviours:</u> food intake (self-report and visual records with a digital camera)

Reference	Population characteristics (sport, n (male + female), age; BMI or BW and height)	Study design [follow-up] Time points	Outcomes (method)
Lingor, 2010 67 (USA)	<u>Wrestling</u> : initial : n = 13 (m), 19.8 ± 1.1 y; 24.7 ± 2.7 kg/m ² final : n = 9	Longitudinal, Observational [1 y] <u>pre-WL-1</u> : baseline (7 wk pre-season) During the season (1 wk pre-competition x 2 competitions): <u>pre-WL-2</u> : Monday + <u>WL-1</u> : 1 d + <u>WL-2</u> : 1 d + <u>WL-3</u> : 1 d + <u>WL-4</u> : 1 d + <u>WL-5</u> : 1 d (Saturday) <u>WG</u> : post-season	<u>Anthropometry/Body composition</u> : BW; FM, FFM, TBW (bioimpedance + underwater weighing); hydration (USG + UOSM, urine sample) <u>Weight management</u> : questionnaire <u>Energy intake, dietary and eating behaviours</u> : food and fluid intake (2 x 1-wk food record: beginning + end of season) <u>Energy expenditure</u> : REE (estimated by bioimpedance at baseline + Harris-Benedict equation)
McCargar, 1992 74 (Canada)	<u>Wrestling</u> : n = 13 (m) WC : n = 8, 20 ± 3 y; 72.4 ± 11.9 kg; 173.5 ± 5.5 cm non-WC (CT) : - non-DIET initial : n = 6, 20 ± 2 y; 78.2 ± 10.1 kg; 175.4 ± 6.5 cm - non-DIET final : n = 5	Longitudinal, Observational, Controlled [6 mo] <u>pre-WL</u> : pre-season (5-6 wk pre-competition) <u>WL-1</u> : 5 wk (1 wk pre-competition) + <u>WL-2</u> : 1 wk (weigh-in) <u>WG</u> : off-season (5 mo post-competition)	<u>Anthropometry/Body composition</u> : BW; FM, FFM (skinfolds) <u>Weight management</u> : questionnaire <u>Energy intake, dietary and eating behaviours</u> : eating behaviours (questionnaire); food intake (3-d food record) <u>Physical activity</u> : exercise habits (questionnaire) <u>Biological parameters</u> : T3 (blood sample) <u>Energy expenditure</u> : REE (indirect calorimetry)
Öopik, 2013 68 (Estonia)	<u>Wrestling</u> : n = 51 (m), 20.7 ± 3.7 y; NR; 177.1 ± 7.2 DIET : n = 27 non-DIET (CT) : n = 24	Transversal, Observational, Controlled [1 d] <u>WL</u> : weigh-in <u>WG</u> : 16 h (20 min before the first match)	<u>Anthropometry/Body composition</u> : BW; hydration (USG + UOSM, urine sample) <u>Weight management</u> : questionnaire
Oppliger, 2003 14 (USA)	<u>Wrestling</u> : n = 741 (m), 20.0 ± 1.6 y; 73.2 ± 10.2 kg; 174.1 ± 6.9 cm LW : n = NR, 19.6 ± 1.4 y; 63.8 ± 4.5 kg*; 169.6 ± 5.5 cm* MW : n = NR, 20.0 ± 1.5 y; 74.7 ± 4.4 kg*; 174.8 ± 5.3 cm* HW : n = NR, 20.3 ± 1.7 y+; 86.6 ± 6.6 kg*; 180.5 ± 5.3 cm* D1 : n = 275, 20.0 ± 1.5 y; 72.4 ± 9.9 kg; 173.2 ± 6.9 cm¶ D2 : n = 167, 20.2 ± 1.6 y¶; 73.9 ± 9.4 kg; 173.9 ± 6.5 cm D3 : n = 299, 19.8 ± 1.6 y¶; 73.6 ± 11.0 kg; 175.0 ± 7.0 cm¶	Transversal, Observational, Retrospective [N/A] <u>pre-WL</u> : current weight <u>WL</u> : weekly weight lost <u>WG</u> : post-season	<u>Weight management</u> : questionnaire
Oppliger, 2006 72 (USA)	<u>Wrestling</u> : n initial = 811 (m) LW : n = 315 MW : n = 290 HW : n = 206 D1 : - D1 initial : n = 385, NR; 73.3 kg; NR - D1 final : n = 300 D2 : - D2 initial : n = 195, NR; 75.2 kg; NR - D2 final : n = 108 D3 : - D3 initial : n = 231, NR; 74.0 kg; NR - D3 final : 192	Longitudinal, Observational [N/A] <u>pre-WL</u> : beginning of the season <u>WL</u> : pre-competition day <u>WG</u> : day of competition (after weigh-in)	<u>Anthropometry/Body composition</u> : BW; height; FM, FFM (skinfolds)
Ransone, 2004 75 (USA)	<u>Wrestling</u> : n = 78 (m), 21.3 ± 1.5 y; 73.93 ± 11.62 kg; 154.1 ± 0.5 cm	Longitudinal, Observational [9 mo] <u>pre-WL</u> : 1 mo pre-season (Sept) <u>WL-1</u> : 24h pre-match + <u>WL-2</u> : 1h pre-match (weigh-in, Nov) <u>WG-1</u> : 24h post-match + <u>WG-2</u> : 2 mo (Jan) + <u>WG-3</u> : 2 mo (March) + <u>WG-4</u> : 2 mo (1 mo after last competition, May)	<u>Anthropometry/Body composition</u> : BW; height; FM, FFM (skinfolds); hydration (USG, urine sample)

Reference	Population characteristics (sport, n (male + female), age; BMI or BW and height)	Study design [follow-up] Time points	Outcomes (method)
Scott, 1994 69 (USA)	Wrestling: n = 668 (m), NR; NR HW: n = 61 non-HW: n = 607 LW: n = 68 D1: n = 333 D2: n = 137 D3: n = 198	Transversal, Observational [1 d] WL: weigh-in WG: 20 h	<u>Anthropometry/Body composition:</u> BW
Steen, 1990 4 (USA)	Wrestling: n = 204 (m) collegiate: n = 63; 20 ± 1.3; NR; 175.5 ± 6.6 cm high school: n = 139	Transversal, Observational, Retrospective [N/A] WL: season WG: off-season	<u>Weight management:</u> questionnaire
Utter, 1998 76 (USA)	Wrestling: n = 11 (m), NR; 79.4 ± 3.8 kg; NR	Longitudinal, Observational [1 y] pre-WL: baseline (pre-season) WL: 3 mo (mid-season) WG: 3 mo (post-season)	<u>Anthropometry/Body composition:</u> BW; height; FM (skinfolds)
Barley, 2018 44 (Worldwide)	total: n = 637 BJJ: 25% (90% <i>m</i>), 29 ± 7 y; 80.9 ± 19.3 kg; 177 ± 9 cm Boxing: 6% (85% <i>m</i>), 25 ± 6 y; 77.5 ± 13.9 kg; 179 ± 9 cm Judo: 12% (89% <i>m</i>), 28 ± 8 y; 81.2 ± 13.1 kg; 177 ± 8 cm MMA: 11% (96% <i>m</i>), 27 ± 6 y; 82.8 ± 12.6 kg; 178 ± 9 cm MT/K: 12% (95% <i>m</i>), 27 ± 6 y; 75.2 ± 13.7 kg; 178 ± 10 cm TKD: 6% (44% <i>m</i>), 23 ± 6 y; 65.3 ± 13 kg; 171 ± 11 cm Wrestling: 27% (98% <i>m</i>), 21 ± 7 y; 74.3 ± 13.9 kg; 175 ± 9 cm	Transversal, Observational, Retrospective [N/A] pre-WL: current weight WL: habitual WL duration WG: 7 d (post-competition)	<u>Weight management:</u> RWLQ
Cheah, 2019 94 (Malaysia)	Jiu-jitsu, judo, karate, muay thai, TKD, silat: n = 65 (44 <i>m</i> + 21 <i>f</i>), 22.9 ± 6.8 y; 62.3 ± 13.7 kg; 164.4 ± 9.5 cm WC: n = 43 (29 <i>m</i> + 14 <i>f</i>), 23 ± 6.6 y; 63.4 ± 13.1 kg; 164.2 ± 10.1 cm non-WC: n = 22 (15 <i>m</i> + 7 <i>f</i>), 23 ± 7.4 y; 60.2 ± 14.9 kg; 164.8 ± 8.6 cm	Transversal, Observational, Retrospective [N/A] pre-WL: current weight WL: habitual WL duration WG: 7 d (post-competition)	<u>Weight management:</u> RWLQ
Pettersson, 2012 51 @ (Sweden)	Judo, TKD, wrestling: n = 14 (9 <i>m</i> + 5 <i>f</i>), NR; NR	Transversal, Observational [N/A]	<u>Weight management:</u> semi-structured interview
Pettersson, 2013 52 @ (Sweden)	Judo, TKD, wrestling: n = 14 m: n = 9, 24 y; 86 kg; NR f: n = 5, 26 y; 67 kg; NR DIET: n = 11 (7 <i>m</i> + 4 <i>f</i>) non-DIET: n = 3	Transversal, Observational [N/A]	<u>Weight management:</u> semi-structured interview
Pettersson, 2014 70 (Sweden)	total: n = 68 (47 <i>m</i> + 21 <i>f</i>), 21.3 ± 3.8 y; 70.2 ± 17.6 kg; 177 ± 10.2 cm Boxing, judo: morning weigh-in (MWI): n = 35 TKD, wrestling: evening weigh-in (EWI): n = 33	Transversal, Observational [2 d] WL: weigh-in WG: 30 min before match: - total: 13.1 ± 6.1 h - MWI: 8.2 ± 3.5 h - EWI: 18.4 ± 3.0 h	<u>Anthropometry/Body composition:</u> BW <u>Energy intake, dietary and eating behaviours:</u> food and fluid intake (24-h food record)

Reference	Population characteristics (sport, n (male + female), age; BMI or BW and height)	Study design [follow-up] Time points	Outcomes (method)
Reale, 2018 100 (Australia)	total: n = 229 (150m + 80f), 23.1 ± 5.9 y; 67.0 ± 13.2 kg; 172.5 ± 9.8 cm Boxing: n = 71, 24.9 ± 4.9 y; 65.6 ± 11.3 kg; 173.6 ± 9.4 cm Judo: n = 68, 22.9 ± 7.3 y; 68.3 ± 15.8 kg; 170.5 ± 10.5 cm TKD: n = 57, 22.5 ± 4.6 y; 64.2 ± 12.1 kg; 173.2 ± 10.5 cm Wrestling: n = 33, 25.0 ± 6.3 y; 72.4 ± 11.1 kg; 173.1 ± 7.4 cm	Transversal, Observational, Retrospective [N/A] pre-WL: current weight WL: habitual WL duration WG: 7 d (post-competition)	Weight management: RWLQ
Imposed WL conditions only			
Sagayama, 2019 40 ☀ (Japan)	Boxing: n = 7 (m), 20 ± 1 y; 70.9 ± 6.5 kg; 178 ± 2 cm	Longitudinal, Interventional [15 d] pre-WL: baseline (1 wk maintenance) WL: 7 d lose > 5 % of baseline BW in 7 d using self-selected methods WG-1: 3 h + WG-2: 9 h + WG-3: 15 h	Anthropometry/Body composition: BW; height; FM, FFM, TBW (underwater weighing + doubly water) Energy intake, dietary and eating behaviours: food intake (3 to 7-d food record) Energy expenditure: EE, SMR, RER, DIT, substrates oxidation (indirect calorimetry in chamber) Physical fitness/performance: maximal oxygen uptake (treadmill test)
Sagayama, 2014 53 ☀ (Japan)	Judo, wrestling: n = 10 (m), 20.0 ± 1.4 y; 74.4 ± 9.0 kg; 174.6 ± 6.8 cm	Longitudinal, Interventional [15 d] pre-WL: baseline (1 wk maintenance) WL: 7 d lose > 5 % of baseline BW in 7 d using self-selected methods WG: 1 d <i>ad libitum</i> diet for 12 h	Anthropometry/Body composition: BW; height; FM, FFM, TBW (underwater weighing + doubly water) Energy intake, dietary and eating behaviours: food intake (food record during all the study) Physical activity: PAL (accelerometer) Energy expenditure: EE, REE, SMR (indirect calorimetry in chamber)
Imposed WG conditions only			
Degoutte, 2006 43 (France)	Judo: n = 20 (m) DIET: n = 10, NR; 24.9 ± 0.8 kg/m ² non-DIET (CT): n = 10, NR; 23.0 ± 1.3 kg/m ²	Longitudinal, Interventional, Controlled [13 d] pre-WL: baseline (4 wk before WL) WL: 7 d WG: ~ 3 h (10 min post-competition) competition day: 5 matches of 5 min (30 min rest) - 300 mL water after each match - meal after matches 1, 2 and 3: 334 kcal (55.9 % CHO + 6.7 % lip + 4.9 % prot)	Anthropometry/Body composition: BW; height; FM (skinfolds) Energy intake, dietary and eating behaviours: food intake (7-d food record) Biological parameters: glucose, TG and alkali reserve, FFA, blood glycerol and ammonia, uric acid, urea, creatinine, hormonal markers (fasting blood sample) Physical fitness/performance: muscle strength (hand grip), power and anaerobic work capacity (upper limb isometric dynamometer 30-s) Psychological status: POMS
Imposed WL and WG conditions			
Kondo, 2019 50 § (Japan)	Wrestling: n = 8 (m), 20.4 ± 0.5 y; 73.0 ± 7.9 kg; 168.4 ± 4.2 cm	Transversal, Interventional [3 d] pre-WL: baseline WL: 53h lose 6% of initial BW in 53h max WG: 13h	Anthropometry/Body composition: BW; height; body volume, thoracic gas volume (BOD POD); TBW (doubly labelled water); FM, FFM, BMC (DXA) Energy intake, dietary and eating behaviours: food intake (3-d food record)
Kondo, 2021 41 § (Japan)	Wrestling: n = 10 (m), 20.9 ± 0.5 y; 73.2 ± 8.2 kg; 168.9 ± 4.3 cm	Longitudinal, Interventional [10 d] pre-WL: baseline (7 d before WL period) WL: 53 h 6 % RWL in 53h, usual procedure WG-1: 2 h prescribed <i>ad libitum</i> meal (17:30 pm - 19:00 pm) WG-2: 2 h prescribed <i>ad libitum</i> meal (21:00 pm - 22:00 pm) WG-3: 9 h prescribed <i>ad libitum</i> (22:30 pm - 23:00 pm)	Anthropometry/Body composition: BW; height; FM, FFM, BMC (DXA); muscle and subcutaneous fat in the femoral CSA (MRI) Energy intake, dietary and eating behaviours: food intake (3-d food record and 53-h during WL) Biological parameters: muscle glycogen concentration (MRS); haemoglobin, haematocrit, total protein, albumin, creatinine, uric acid, urea nitrogen, glucose, insulin, TG, FFA, total-C, HDL-C, LDL-C, sodium, potassium, chlorine, magnesium, arginine vasopressin and testosterone (fasting blood sample); urinary specific gravity, osmotic pressure (urine sample)

Reference	Population characteristics (sport, n (male + female), age; BMI or BW and height)	Study design [follow-up] Time points	Outcomes (method)
Õopik, 2002 95 (Estonia)	<u>Wrestling</u> : n = 5 (m), 20.6 ± 0.9 y; 23.0 ± 1.5 kg/m ²	Transversal, Interventional, Controlled, Double blind [3 d] x2 (same group, 1 mo apart) <u>pre-WL</u> : baseline <u>WL</u> : 56 h lose 5% of baseline BW in 53 h with habitual methods <u>WG</u> : 17 h placebo phase : 1 st test without supplementation (glucose placebo) creatine phase : 2 nd test with supplementation (creatine + glucose)	<u>Anthropometry/Body composition</u> : BW <u>Energy intake, dietary and eating behaviours</u> : food intake (food-record) <u>Physical activity</u> : training program (dairy) <u>Biological parameters</u> : haemoglobin concentration, plasma volume, lactate, glucose, urea (blood sample after WL and WG); urinary volume, urinary creatine concentration (urine sample) <u>Physical fitness/performance</u> : muscle strength (isokinetic leg dynamometer)
Rankin, 1996 71 (USA)	<u>Wrestling</u> : n = 12 (NR) high CHO (HC) : n = 6, 21.2 ± 0.5 y; 72.7 ± 5.8 kg; 172.4 ± 3.4 cm medium CHO (MC) : n = 6, 19.8 ± 0.5 y; 70.0 ± 3.3 kg; 166.7 ± 3.0 cm	Longitudinal, Interventional [5 d] <u>pre-WL</u> : baseline <u>WL</u> : 72 h hypo-energy diet: 18 kcal/kg, 60% CHO, without dehydration <u>WG</u> : 5 h diet with a scheduled pattern: 21 kcal/kg: - HC: 75% CHO + 15% lip + 10% prot - MC: 47% CHO + 37% lip + 16% prot	<u>Anthropometry/Body composition</u> : BW; FM (skinfolds) <u>Biological parameters</u> : PCO ₂ , lactate, glucose, pH (blood sample 5min before and 1min after performance test) <u>Physical fitness/performance</u> : power and anaerobic work capacity (hand grip ergometer adapted from bicycle)
Fogelholm, 1993 103 (N/A)	total : n = 10 (m), 21.6 y; 73.1 kg; 174 cm <u>Wrestling</u> : n = 7 <u>Judo</u> : n = 3	Longitudinal, Interventional [2 mo] <u>pre-WL-1</u> : baseline <u>WL-1</u> : 3 wk gradual WL - energy intake: decrease by 1000 kcal - instructions: reduced fatty foods <u>WG-1 = pre-WL-2</u> : 1 wk (2 mo after pre-WL-1) <u>WL-2</u> : 59 h rapid WL (dehydration) - same amount of WL than WL-1 - severe dietary and fluid restriction - exercise with plastic suit - diuretics and laxatives prohibited <u>WG-2</u> : 5 h rehydration + <i>ad libitum</i> diet <u>WL-3</u> : 1 night overnight fast	<u>Anthropometry/Body composition</u> : BW <u>Energy intake, dietary and eating behaviours</u> : food and fluid consumption (4-d food record) <u>Physical activity</u> : PAL (physical activity record) <u>Biological parameters</u> : transketolase activation coefficient, glutathione reductase activation coefficient, aspartate aminotransferase activation coefficient, ferritin, potassium, magnesium, zinc (fasting blood samples) <u>Physical fitness/performance</u> : lower limb explosiveness (vertical jump), power and anaerobic work capacity (Wingate 30-s bicycle + sprints)
Strength and conditioning sports			
Usual athletes' methods of WL and WG (not imposed by the study design)			
Andersen, 1995 15 (USA)	<u>Bodybuilding</u> : n = 45 (m), 26.4 ± 0.92 y; 76.3 ± 3.06 kg; 174.9 ± 0.51 cm	Transversal, Observational, Retrospective [N/A]	<u>Weight management</u> : questionnaire
Halliday, 2016 16 (USA)	<u>Bodybuilding</u> : n = 1 (f), 26 - 27 y; 19.4 kg/m ²	Longitudinal, Observational, Case study [21 mo] <u>pre-WL</u> : baseline <u>WL-1</u> : 1 wk + <u>WL-2</u> : 9 wk + <u>WL-3</u> : 10 wk <u>WG-1</u> : 10 wk + <u>WG-2</u> : 10 wk + <u>WG-3</u> : 12 wk + <u>WG-4</u> : 39 wk	<u>Anthropometry/Body composition</u> : BW; FM, FFM (DXA + skinfolds) <u>Energy intake, dietary and eating behaviours</u> : food intake (daily food record) <u>Physical activity</u> : training program (exercise training record) <u>Energy expenditure</u> : exercise EE (daily exercise training diary); energy availability (calculated)

Reference	Population characteristics	Study design [follow-up]	Outcomes (method)
	(sport, n (male + female), age; BMI or BW and height)	Time points	
Pardue, 2017 80 (NR)	Bodybuilding: n = 1 (m), 21 y; 85.2 kg; NR	Longitudinal, Observational, Case study [1 y] <u>pre-WL:</u> baseline <u>WL:</u> monthly measure (WL-1 to WL-7 (competition)) <u>WG:</u> monthly measure (WG-1 to WG-5)	<u>Anthropometry/Body composition:</u> BW; FM, FFM (DXA + plethysmography) <u>Energy intake, dietary and eating behaviours:</u> dietary program report <u>Physical activity:</u> training program <u>Biological parameters:</u> testosterone, leptin, T3, T4, cortisol, ghrelin (blood samples) <u>Energy expenditure:</u> REE (Cunningham equation) <u>Fitness:</u> power and anaerobic work capacity (Wingate 30-s bicycle) <u>Other:</u> sleep quality (Sleep Quality Index + accelerometer)
Rossov, 2013 81 (NR)	Bodybuilding: n = 1 (m), 26 - 27 y; 67.4 kg; 171.5 cm	Longitudinal, Observational, Case study [1 y] <u>pre-WL:</u> baseline <u>WL:</u> monthly measure (WL-1 to WL-6 (competition)) <u>WG:</u> monthly measure (WG-1 to WG-6)	<u>Anthropometry/Body composition:</u> BW; BMC (DXA); TBW (bioimpedance spectroscopy); body volume (plethysmography); FM, FFM (estimated from 4-C model); hydration (USG, urine sample) <u>Energy intake, dietary and eating behaviours:</u> food intake (food-record) <u>Physical activity:</u> training program (exercise training record) <u>Biological parameters:</u> brachial DBP and SDP (blood pressure-measuring device); pulse-wave velocities (strain-gauge transducer); calf and forearm blood; cardiac output, stroke volume, end diastolic volume, end systolic volume, ejection fraction (echocardiography); testosterone, leptin, ghrelin, cortisol, insulin, T3, T4 (blood samples) <u>Energy expenditure:</u> REE (indirect calorimetry) <u>Physical fitness/performance:</u> muscle strength (1RM: squat, bench press and deadlift); maximal oxygen uptake (bicycle ergometer test) <u>Psychological status:</u> POMS
Tinsley, 2019 82 (USA)	Bodybuilding: n = 1 (f), 29 y; 65 kg; 167.6 cm	Longitudinal, Observational, Case study [34 wk] <u>pre-WL:</u> baseline <u>WL:</u> <u>WL-1:</u> 27 d + <u>WL-2:</u> 28 d + <u>WL-3:</u> 32 d + <u>WL-4:</u> 17 d + <u>WL-5:</u> 19 d (3 d pre-comp1): program made by the coach of the athlete: 4 - 6 d/wk resistance training + 3 - 6 d/wk aerobic training (cycling, walking/running, stepping exercise, HIIT) <u>WG-1:</u> 5 d (post-comp-1) <u>WL-6:</u> 22 d + <u>WL-7:</u> 19 d (3 d pre-comp-2) <u>WG-2:</u> 5 d (post-comp-2) + <u>WG-3:</u> 28 d + <u>WG-4:</u> 29 d	<u>Anthropometry/Body composition:</u> BW; BMC, FFM, body volume (DXA); FM (estimated from the 4-C model); TBW (bioimpedance) <u>Energy intake, dietary and eating behaviours:</u> food intake and supplementation prescribed by coach (recorded); eating behaviours (TFEQ-R18) <u>Physical activity:</u> training program <u>Energy expenditure:</u> REE, RER, substrates oxidation (indirect calorimetry); vascular assessment (oscillometric blood pressure monitor) <u>Physical fitness/performance:</u> muscle strength (isometric and isokinetic squats)
Hulmi, 2017 39 — (Finland)	Fitness: n = 50 (f) DIET: n = 27, 27.2 ± 4.1 y; 64.3 ± 6.9 kg; 165.3 ± 4.3 cm non-DIET (CT): n = 23, 27.7 ± 3.7 y; 64.3 ± 5.3 kg; 165.9 ± 5.7 cm	Longitudinal, Observational, Controlled [8 mo] <u>pre-WL:</u> baseline <u>WL:</u> 19.8 ± 3.6 wk <u>WG:</u> 17.5 ± 2.6 wk Standard conditions for each test day: - 8 h of fasting - standardized low-fat breakfast (~72 - 80 g CHO + ~6 g lip + ~47 - 48 g prot)	<u>Anthropometry/Body composition:</u> BW; FM, FFM (DXA + bioimpedance + skinfolds); BMC (DXA); vastus lateralis/triceps muscle and fat thickness and/or CSA (B-mode axial plane ultrasound) <u>Energy intake, dietary and eating behaviours:</u> food intake (4-d food record) <u>Physical activity:</u> training program (diary) <u>Biological parameters:</u> blood pressure, heart rate (blood pressure monitor); haemoglobin, haematocrit, cortisol, testosterone, oestradiol, T3, T4, TSH, leptin (fasting blood samples); menstrual status (Reproductive Function Questionnaire) <u>Physical fitness/performance:</u> muscle strength (1RM: leg and bench press), lower limb explosiveness (vertical jump) <u>Psychological status:</u> POMS-Adolescent (Finnish version)
Sarin, 2019a 54 — (Finland)	Fitness: n = 42 (f) DIET: n = 25, 27.2 ± 4.2 y; 23.54 ± 1.82 kg/m ² non-DIET (CT): n = 17, 27.8 ± 3.8 y; 23.08 ± 1.36 kg/m ²	Longitudinal, Observational, Controlled [9 mo] <u>pre-WL:</u> baseline <u>WL:</u> 21.1 ± 3.1 wk <u>WG:</u> 18.4 ± 2.9 wk	<u>Anthropometry/Body composition:</u> BM; height; BMI; FM, FFM (DXA); waist circumference <u>Energy intake, dietary and eating behaviours:</u> food intake (food record) <u>Physical activity:</u> training program (diary) <u>Biological parameters:</u> RNA-seq, IgG glucose, white blood cells, cytokines (fasting blood samples)

Reference	Population characteristics (sport, n (male + female), age; BMI or BW and height)	Study design [follow-up] Time points	Outcomes (method)
Sarin, 2019b 55 — (Finland)	Fitness: n = 42 (f), 27.5 ± 4.0 y DIET: n = 25, NR; 23.54 ± 1.82 kg/m ² non-DIET (CT): n = 17, NR; 23.08 ± 1.36 kg/m ² non-athletes: FINRISK study sample: n = 58 (f), 29.3 ± 2.5 y; 22.90 ± 2.60 kg/m ²	Longitudinal, Observational, Controlled [9 mo] pre-WL: baseline WL: 21.1 ± 3.1 wk WG: 18.4 ± 2.9 wk	Anthropometry/Body composition: BW; height; FM, FFM, visceral FM (DXA + ultrasound); waist and hip circumferences Energy intake, dietary and eating behaviours: food intake (food record) Physical activity: training program (diary); PAL (International Physical Activity Questionnaire for FINRISK subjects) Biological parameters: metabolomics measures (NMR); PON-1, CETP, ANGPTL (blood samples)
Sarin, 2021 42 — (Finland)	Fitness: n = 42 (f), 27.5 ± 4.0 y; 23.4 ± 1.7 kg/m ² DIET: n = 25, 27.2 ± 4.2 y; 23.5 ± 1.8 kg/m ² non-DIET (CT): n = 17, 27.8 ± 3.8 y; 23.1 ± 1.4 kg/m ²	Longitudinal, Observational, Controlled [9 mo] pre-WL: baseline WL: 21.1 ± 3.1 wk WG: 18.4 ± 2.9 wk	Anthropometry/Body composition: BW; height; FM, FFM (DXA) Energy intake, dietary and eating behaviours: food intake (food record) Physical activity: exercise habits (self-reported) Biological parameters: transcriptome (blood samples) Physical fitness/performance: muscle strength (1RM: leg and bench press); lower limb explosiveness (vertical jump)
Nolan, 2020 96 (Ireland)	Powerlifting: n = 233 (141m + 92f) WC: n = 200 (117m + 83f), 28.8 ± 8.3 y; 79.4 ± 17.0 kg; 170 ± 10 cm - regular WC: n = 268 (156m + 112f), 29.81 ± 8.61 y, 82.80 ± 28.27 kg; 170 ± 11 cm non-WC: n = 33 (24m + 9f)	Transversal, Observational, Retrospective [N/A] pre-WL: current weight WL: habitual WL duration WG: 7 d (post-competition)	Weight management: RWLQ
Imposed WL conditions only			
Conlin, 2021 97 (USA)	Bodybuilding: n = 23 (10m + 13f), 25.6 ± 6.1 y; 75.4 ± 10.3 kg; 170 ± 8.1 cm flexible DIET (FLEX): n = 11 rigid DIET (RIGID): n = 12	Longitudinal, Interventional, Randomized [20 wk] pre-WL: baseline WL-1: 5 wk + WL-2: 5 wk 25% of caloric restriction - FLEX diet: non-specific foods - RIGID diet: specific foods WG-1: 6 wk + WG-2: 4 wk <i>ad libitum</i> diet	Anthropometry/Body composition: BW; FM, FFM (ultrasound) Energy intake, dietary and eating behaviours: food intake (3-d food record); eating behaviours (TFEQ) Energy expenditure: REE (indirect calorimetry)
Combat sports + strength and conditioning sports + other sports			
Marquet, 2013 101 (France)	total: n = 142 (NR), 40.4 ± 6.9 y; NR DIET: n = 104, NR; 21.5 kg/m ² - boxing: n = 22 (m), 41.64 ± 4.86 y; 62.85 ± 7.88 kg; 174 ± 6 cm - judo: n = 16 (8m + 8f), 41.06 ± 6.19 y; 68.05 ± 10.20 kg; 170 ± 8 cm - LW rowing: n = 33 (26m + 7f), 38.45 ± 7.33 y; 70.59 ± 6.29 kg; 179 ± 6 cm - wrestling: n = 33 (28m + 5f), 41.94 ± 6.57 y; 70.00 ± 12.22 kg; 171 ± 7 cm non-DIET (CT): n = 38, NR; 22.6 kg/m ²	Longitudinal, Observational, Controlled, Retrospective [22 y] WL: during career (from 18 to 30 yo) WG-1: end of career + WG-2: post-career	Anthropometry/Body composition: BW, height (phone interviews); BMI Weight management: frequency and amount of WL (phone interview) Energy intake, dietary and eating behaviours: eating behaviours (EAT-26) Physical activity: exercise habits (phone interview)
Péllissier, 2022 98 (France)	Boxing, jiu-jitsu, judo, karate, MMA, powerlifting, TKD, weightlifting, wrestling, viet vo dao, voseikan budo: n = 168 (81m + 87f), 24 ± 9 y; 23.4 ± 2.9 kg/m ²	Transversal, Observational, Retrospective [N/A] pre-WL: current weight WL: habitual WL duration WG: 7 d (post-competition)	Weight management: RWLQ

Reference	Population characteristics (sport, n (male + female), age; BMI or BW and height)	Study design [follow-up] Time points	Outcomes (method)
Saarni, 2006 102 (Finland)	<p>total:</p> <ul style="list-style-type: none"> - at 20 years old: n = 2033 (m) - in 1985: n = 1726 (m) - in 1995: n = 1074 (m) - in 2001: n = 470 (m) <p><u>Boxing, weightlifting, wrestling (WC):</u></p> <ul style="list-style-type: none"> - WC at 20 years old: n = 273, 20 y; 22.8 kg/m² - WC in 1985: n = 253, 52.8 y - WC in 1995: n = 127 - WC in 2001: n = 56 <p><u>Basketball, cross-country skiing, football, ice hockey, track and field athletics, shooting (non-WC, CT):</u></p> <ul style="list-style-type: none"> - non-WC at 20 years old: n = 1093, 20 y; 22.6 kg/m² - non-WC in 1985: n = 830, 51.7 y - non-WC in 1995: n = 700 - non-WC in 2001: n = 247 <p><u>Non-athletes (NA):</u></p> <ul style="list-style-type: none"> - NA at 20 years old: n = 667, 20 y; 22.7 kg/m² - NA in 1985: n = 623, 51.1 y - NA in 1995: n = 247 - NA in 2001: n = 167 	<p>Longitudinal, Observational, Controlled, Retrospective [16 y]</p> <p>T0: 20 years old (retrospective) T1: 1985 T2: 1995 T3: 2001</p>	<p><u>Anthropometry/Body composition:</u> BMI, weight change since 20 y (self-reported) <u>Energy intake, dietary and eating behaviours:</u> type of milk used (self-reported) <u>Physical activity:</u> exercise habits (questionnaire)</p>
Morris, 1996 77 (Australia)	<p>Rowing: n = 18</p> <p>m: n = 12, 23.5 ± 3.5 y; 75.6 ± 3.1 kg; 180.5 ± 2.7 cm</p> <p>f: n = 6, 23.1 ± 4.5 y; 61.3 ± 2.9 kg; 170.8 ± 5.6 cm</p>	<p>Longitudinal, Observational [9 mo]</p> <p><u>pre-WL:</u> pre-season (October) <u>WL-1:</u> early-competition + <u>WL-2:</u> competition <u>WG:</u> post-competition (July)</p>	<p><u>Anthropometry/Body composition:</u> BW; height; FM, FFM (DXA + skinfolds); BMD (DXA) <u>Weight management:</u> questionnaire <u>Energy intake, dietary and eating behaviours:</u> food intake (3-d food record)</p>
Soldiers			
Usual soldiers WL and WG habits			
Allen, 2021 104 (USA)	<p><u>Soldiers:</u> n = 575 (515m + 60f)</p> <p>WC: n = 190 (171m + 19f), 23.0 ± 4.3 y; 26.9 ± 3.8 kg/m²*</p> <p>non-WC (CT): n = 385 (344m + 41f), 23.0 ± 4.5 y; 25.1 ± 3.3 kg/m²*</p>	<p>Transversal, Observational, Controlled [N/A]</p>	<p><u>Anthropometry/Body composition:</u> BW, height (self-reported) <u>Weight management:</u> weight management behaviours (Military Eating Behavior Scale) weight cycling (1 question) <u>Energy intake, dietary and eating behaviours:</u> diet quality (Healthy Eating Index)</p>
Imposed WL conditions			

Reference	Population characteristics (sport, n (male + female), age; BMI or BW and height)	Study design [follow-up] Time points	Outcomes (method)
Conkright, 2020 37 (USA)	<u>Soldiers</u> : n = 10 (m), 24.0 ± 5.0 y; 25.7 ± 2.0 kg/m ²	Longitudinal, Interventional [6 wk] <u>pre-WL</u> : baseline <u>WL</u> : 62 d ranger course: - sleep and caloric restriction (1200 kcal deficit/d) - physical exertion (20 h/d/7 day a week) - graded evaluations <u>WG-1</u> : 2 wk + <u>WG-2</u> : 4 wk (post course)	<u>Anthropometry/Body composition</u> : BW; FM, FFM (DXA) <u>Physical fitness/performance</u> : ranger Athlete Warrior assessment (version 2.0): agility (Illinois agility test); core strength and endurance (heel clap); muscle strength (overhand grip pull-up, metronome push-up, 185-lbs bench press, 225-lbs deadlift); power and anaerobic work capacity (300-yard shuttle run); maximal oxygen uptake (20-m multistage beep test by Léger et al.)
Imposed WL and WG conditions			
Friedl, 2000 35 (USA)	<u>Soldiers</u> : n = 105 (m) group-1 (g1) : n = 55, 23.6 ± 2.8 y; 24.3 ± 2.1 kg/m ² group-2 (g2) : n = 50, 23.0 ± 3.9 y; 25.5 ± 2.0 kg/m ² - g2 subgroup (g2sub) : n = 10	Longitudinal, Interventional [13 wk] US Army Ranger course, 1 y apart for each group <u>pre-WL</u> : baseline <u>WL-1</u> : 2 wk (g1) semistarvation ^a (7 – 10 d) + refeeding (4 – 7 d) <u>WL-2</u> : 2 wk (g1 & 2) semistarvation ^a <u>WG-2</u> : 1 wk (g2) refeeding <u>WL-3</u> : 1 wk (g1 & 2) semistarvation ^a <u>WL-4</u> : 2 wk (g1 & 2) semistarvation ^a (7 – 10 d) + refeeding (4 – 7 d) <u>WG-4</u> : 5 wk (g2 subgroup, after the end of the course) ^a semistarvation: restricted energy intakes (1 meal/d, g1: 1200 kcal/d and g2: 1000 kcal/d)	<u>Anthropometry/Body composition</u> : BW; height; BMI; FM, FFM (DXA + skinfolds); BMC (DXA); abdominal circumferences <u>Biological parameters</u> : IGF-1, T3, T4, TBG, TSH, LH, SHBG, cortisol, testosterone, serum lipids, total-C, HDL-C, LDL-C (fasting blood sample)
Nindl, 1997 36 (USA)	<u>Soldiers</u> : n = 10 (m), 23 ± 2.7 y; 74.1 ± 9.1 kg; 177.0 ± 7.7 cm	Longitudinal, Interventional [14 wk] <u>pre-WL</u> : baseline (before course) <u>WL</u> : 62 d ranger course: - sleep and caloric restriction (1000 kcal deficit/d) - physical exertion (20h/d/7day a week) - graded evaluations <u>WG</u> : 35 d (post course) <i>ad libitum</i> eat after the course	<u>Anthropometry/Body composition</u> : BW; FM, FFM (DXA) <u>Biological parameters</u> : LH, SHBG, IGF-1, T3, T4, TBG, TSH, protein, iron, fat, glycerol, AGL, lactate (fasting blood samples) <u>Physical fitness/performance</u> : muscle strength (power clean with weight stack machine stimulation)

Reference	Population characteristics (sport, n (male + female), age; BMI or BW and height)	Study design [follow-up] Time points	Outcomes (method)
Øfsteng, 2020 34 (Norway)	Soldiers: n = 38 (31m + 7f), 21.6 ± 0.8 y, NR, 182 ± 9 cm low protein intake (LOW): n = 19 (15m + 4f) high protein intake (HIGH): n = 19 (16m + 3f)	Longitudinal, Interventional [17 d] <u>pre-WL:</u> baseline (7 d pre-military exercise) <u>WL:</u> 10 d military exercise + energy deficit (~15 kcal/kg/d), random groups: - LOW protein intake (1 g/kg/d) - HIGH protein intake (2 g/kg/d) <u>WG:</u> 7 d <i>ad libitum</i> refeeding + physical activity	<u>Anthropometry/Body composition:</u> BW; FM, FFM (DXA) <u>Energy intake, dietary and eating behaviours:</u> food intake (24-h food record at pre-WL) <u>Physical activity:</u> exercise habits, sleeping (daily record) <u>Biological parameters:</u> total testosterone, cortisol, IGF-1, SHBG, T3, T4, TSH, creatine kinase (fasting blood samples) <u>Energy expenditure:</u> Exercise EE, REE (estimated from body composition) <u>Physical fitness/performance:</u> lower limb explosiveness (vertical jump: counter-movement jump); muscle strength (1RM: leg and bench press); power and anaerobic work capacity (Wingate 30-s sprint)

—, §, @, ►, ☼: same cohort between studies with the same symbol; *, ¶, #, £: significant difference between groups with the same symbol; *italic*: raw data; 1RM: one maximal voluntary contraction; ANGPTL: angiotensin-like; BJJ: brazilian jiu-jitsu; BMC: bone mineral content; BMD: bone mineral density; BMI: body mass index; BW: body weight; CETP: cholesteryl ester transfer protein; CHO: carbohydrates; CSA: cross-sectional area; CT: control group; CTx: corporate trade exchange; d: day; D1/D2/D3: Division I/II/III; DBP/SDP: diastolic/systolic blood pressure; DIET: dieters; DIT: diet-induced thermogenesis; EAT: eating attitudes test; f: female; FFA: free fatty acid; FFM: fat-free mass; FFQ: food frequency questionnaire; FM: fat-mass; H: hour; HDL/LDL-C: high/low density lipoprotein; HIIT/MIIS/LISS: high/moderate/low intensity interval training; IGF-1: insulin-like growth factor 1; LH: luteinizing hormone; Lip: lipids; LPL: lipoprotein lipase; LW/MW/HW: lightweight/middleweight/heavyweight; m: male; MEBS: method of empathy based stories; MMA: mixed martial art; mo: month; MRI: magnetic resonance imaging; MT/K: muay thai/kickboxing; N/A: not-applicable; NMR: nuclear magnetic resonance; NR: not reported; PAL: physical activity level; POMS: profile of moods questionnaire; PON-1: paraoxonase-1; Prot: proteins; REE: resting energy expenditure; RER: respiratory exchange rate; RWLQ: rapid weight loss questionnaire; RNA-seq: ribonucleic acid sequencing; SD: standard deviation; SHBG: sex hormone-binding globulin; SMR: sleeping metabolic rate; T3/T4: triiodothyronine/thyroxine hormones; TBG: thyroid-binding globulin; TBW: total body water; TEE: total energy expenditure; TKD: taekwondo; TFEQ: three factor eating questionnaire; TG: triglycerides; total-C: total cholesterol; TSH: thyroid-stimulating hormone; UOSM: urine osmolality; USG: urine specific gravity; VO2/VCO2: oxygen/carbon dioxide consumption; WC: weight-cyclers; WG: weight gain; wk: week; WL: weight loss; y: year.

Table S3. Weight loss methods, weight gain process, and subsequent body weight and body composition evolution by type of sport in response to imposed or not weight loss and/or weight gain strategies (mean ± SD).

Ref sport group [n]	WL period conditions (food intake, physical activity and other methods)	WG period conditions (food intake, physical activity and other methods)	Main BW and body composition results
Combat sports			
Usual athletes' methods of WL and WG [not imposed by the study design]			
83 <u>Boxing</u> C1 [133] C2 [31]	Usual WL methods and duration: C1 and C2: see Table 1 <u>Usual WL duration (d)^{NAS}:</u> total m: 12.9 ± 11.0 - C1 m: 12.0 ± 9.6 - C2 m: 17.2 ± 16.0 total f: 14.3 ± 10.5 - C1 f: 13.4 ± 10.0 - C2 f: 15.9 ± 11.9	NR	[pre-WL / WL / WG] <u>BW (kg)^{NAS}:</u> total: 68.9 ± 12.2 / 67.2 ± 12.1 / 69.7 ± 12.4 - total m: 70.7 ± 11.8 / 68.9 ± 11.7 / 71.4 ± 12.0 - total f: 56.1 ± 6.1 / 55.0 ± 6.1 / 57.0 ± 6.3 C1: 68.3 ± 10.9 / 66.8 ± 10.9 / 68.8 ± 11.1 - C1 m: 69.7 ± 10.4 / 68.2 ± 10.5 / 70.3 ± 10.5 - C1 f: 55.1 ± 5.5 / 54.1 ± 5.3 / 55.5 ± 5.8 C2: 71.7 ± 16.6 / 69.2 ± 16.3 / 73.5 ± 16.8 - C2 m: 75.7 ± 16.4 / 72.8 ± 16.0 / 77.4 ± 16.9 - C2 f: 57.9 ± 7.1 / 56.6 ± 7.5 / 59.9 ± 6.5 <u>Usual weight variations:</u> C1 and C2: see Table 1
59 <u>Boxing</u> [142]	NR	NR	[WL / WG] <u>BW (kg)^{NAS}:</u> 76.22 ± 11.30 / 78.57 ± 11.0 (+3.8 ± 2.2%) <u>WD (kg):</u> 1.94 ± 1.50
84 <u>Boxing</u> [61]	Usual WL methods and duration: see Table 1	NR	[pre-WL / WL / WG] <u>BW (kg)^{NAS}:</u> 73.9 ± 12.8 / 70.4 ± 12.7 / 73.2 ± 12.9 <u>Usual weight variations:</u> see Table 1 <u>Self-reported RWL (% of sample):</u> 100% <u>Self-reported RWG (% of sample):</u> 70% usually regained up to 3 kg

Ref sport group [n]	WL period conditions (food intake, physical activity and other methods)	WG period conditions (food intake, physical activity and other methods)	Main BW and body composition results
78 Boxing [1]	[WL-2 / WL-3 / WL-4 / WL-5 / WL-6 / WL-7 / WL-8] <u>Energy intake (kcal/d)^{NAS}</u> : 1846 / 1569 / 1762 / 1508 / 1208 / 969 / 192 <u>CHO (g/d)^{NAS}</u> : 126 / 151 / 120 / 113 / 139 / 85.2 / 21.3 <u>Lip (g/d)^{NAS}</u> : 83 / 63.9 / 77 / 54 / 34 / 13 / 0 <u>Prot (g/d)^{NAS}</u> : 149 / 108 / 167 / 148 / 77 / 144 / 21 <u>Physical activity (during T11)^{NAS}</u> : - run ^{NAS} : 45 min/6 d/wk - boxing ^{NAS} : 90 min/5 d/wk - strength and conditioning ^{NAS} : 60 min/2 d/wk	[WG-1 / WG-2] <u>Energy intake (kcal/d)^{NAS}</u> : 2631 / 2185 <u>CHO (g/d)^{NAS}</u> : 395 / 375 <u>Lip (g/d)^{NAS}</u> : 92 / 51 <u>Prot (g/d)^{NAS}</u> : 70.5 / 77	[WL-1 / WL-2 / WL-3 / WL-4 / WL-5 / WL-6 / WL-7 / WL-8 / WG-2] <u>BW during T11 (kg)^{NAS}</u> : 80.8 / 80.4 / 81.2 / 79.6 / 80.4 / 79.8 / 80.3 / 76.2 / 81.3 <u>BW per training camp (kg)^{NAS}</u> : - T1: 88.6 / 85.7 (1mo) / 78.8 (3mo) / 76.2 (3mo, WL-8) - T2, Table 1 & T4: 76.2 - T5: 88.0 / 76.2 (4mo, WL-8) - T6: 93.2 / 86.4 (1mo) / 82.8 (2mo) / 76.2 (2mo, WL-8) - T7: 88.4 / 86.7 (2mo) / 78.8 (3mo) / 76.2 (3mo, WL-8) - T8: 87.8 / 86.9 (1mo) / 83.7 (2mo) / 76.7 (2mo) / 76.2 (2mo, WL-8) - T9: 86.0 / 76.2 (1mo, WL-8) - T10: 87.4 / 83.2 (<1mo) / 81.5 (1mo) / 76.2 (1mo, WL-8) - T11: 89.6 / 88.1 (1mo) / 86.3 (2mo) / 83.5 (3mo) / 76.2 (3mo, WL-8) / 81.3 (3mo, pre-fight) - mean starting BW: 88.6 ± 2.1 - mean total WL: -12.4 ± 2.1 (-13.9 ± 2.0%) <u>FM per training camp (%BW)^{NAS}</u> : - T1: 14.8 / 14.8 (1mo) / 12.8 (3mo) - T6: 20.3 / 17.1 (1mo) / 15.1 (2mo) - T7: 19 / 17.7 (2mo) / 14 (3mo) - T8: 18.1 / 18.5 (1mo) / 16.8 (2mo) / 14.3 (2mo) - T9: 17.4 - T10: 17.4 / 15.7 (<1mo) / 16.2 (1mo) - T11: 18.8 / 19.1 (1mo) / 17.4 (2mo) / 16.4 (2mo) <u>FM per training camp (kg)^{NAS}</u> : - T1: 12.5 / 12.1 (1mo) / 9.76 (3mo) - T6: 18.3 / 14.5 (1mo) / 12.1 (2mo) - T7: 16.0 / 15.1 (2mo) / 10.7 (3mo) - T8: 15.3 / 15.8 (1mo) / 13.6 (2mo) / 10.6 (2mo) - T9: 14.8 - T10: 14.6 / 12.9 (<1mo) / 12.8 (1mo) - T11: 16.1 / 16.5 (1mo) / 14.8 (2mo) / 13.3 (2mo) - mean starting FM: 15.5 ± 1.9 <u>FFM per training camp (kg)^{NAS}</u> : - T1: 69.8 / 66.9 (1mo) / 63 (3mo) - T6: 69.5 / 67.1 (1mo) / 64.9 (2mo) - T7: 66.3 / 66.5 (2mo) / 62.4 (3mo) - T8: 67.0 / 66.1 (1mo) / 64.7 (2mo) / 60.3 (2mo) - T9: 66.4 - T10: 66.9 / 65.4 (<1mo) / 63.1 (1mo) - T11: 67.5 / 66.3 (1mo) / 66.4 (2mo) / 64.4 (2mo) - mean starting FFM: 67.8 ± 1.5
60 Boxing [399]	NR	NR	[WL / WG] <u>BW (kg)^{NAS}</u> : 61.7 ± 6.6 / 66.1 ± 7.2 (+7.2 ± 3.5%)

Ref sport group [n]	WL period conditions (food intake, physical activity and other methods)	WG period conditions (food intake, physical activity and other methods)	Main BW and body composition results
62 Boxing total [100] m [70] f [30]	<p><u>WL methods (% of sample):</u></p> <p>Fluid manipulation:</p> <ul style="list-style-type: none"> - Active dehydration: 30% - Passive dehydration: 9% - Both: 41% <p>Gut content manipulation:</p> <ul style="list-style-type: none"> - Reduce portion sizes or skip meals: 59% - Reduce fibre intake: 3% - Both: 11% <p>Energy intake/CHO manipulation:</p> <ul style="list-style-type: none"> - Reduce CHO intake: 23% - Reduce energy intake: 8% - Both: 10% 	<p><u>Food intake (% of sample, sum of 'always' and 'sometimes' answers):</u></p> <ul style="list-style-type: none"> - Consumes foods or snacks other than fluid (99%) - Prepares own meals and snacks (92%) - Utilizes pre-packaged meals or snacks (81%) - Purposely consumes high salt foods or adds salt to food (46%) - Consume post weigh-in: grains/ cereals/ pasta/ breads etc. (94%); fruit (92%); meat or fish (85%); vegetables, legumes or beans (78%); sports foods (bars, gels, drinks) (74%); dairy (63%); fats/ oils (60%) - How close to your fight do you consume solid foods: <1 hr (12%) / 1-2 hrs (58%) / >2 hrs (30%) <p><u>Fluid intake (% of sample, sum of 'always' and 'sometimes' answers):</u></p> <p>Consume post weigh-in: water (99%); sports drinks (74%); electrolyte replacement drinks (58%); protein supplements (28%); meal replacement drinks (19%); fruit juice (18%); milk (15%); soft drinks (5%)</p>	<p>[WL-2 / WG] <u>BW (kg)^{NAST}:</u></p> <p>total: 64.49 ± 10.35 / 65.70 ± 10.32 (+1.9 ± 1.6%) m: 66.99 ± 10.4[¶] / 68.35 ± 10.28[¶] (+2.1 ± 1.6%[¶]) f: 58.66 ± 7.6[¶] / 59.49 ± 7.4[¶] (+1.59 ± 1.6%[¶])</p> <p><u>Weight regain:</u> lightest > heaviest weight division group</p>
85 Boxing DIET [10] CT [7]	<p>[pre-WL / WL] <u>Energy intake (kcal/kg/d)^{NASG}:</u></p> <p>DIET: 32 ± 8 / 18 ± 7* (< energy expenditure) CT: 34 ± 6 / 31 ± 8</p> <p><u>CHO (g/kg/d)^{NASG}:</u></p> <p>DIET: 3.8 ± 1.1 / 2.2 ± 0.8* CT: 4.1 ± 0.8 / 3.0 ± 1.2</p> <p><u>Lip (g/kg/d)^{NASG}:</u></p> <p>DIET: 1.3 ± 0.3 / 0.6 ± 0.3* CT: 1.2 ± 0.3 / 1.0 ± 0.4</p> <p><u>Prot (g/kg/d)^{NASG}:</u></p> <p>DIET: 1.5 ± 0.4 / 0.8 ± 0.4* CT: 1.5 ± 0.3 / 1.3 ± 0.4</p> <p><u>Fluid intake (water) (L)^{NASG}:</u></p> <p>DIET: 2.2 ± 0.8 / 1.6 ± 0.6 CT: 1.2 ± 0.3 / 1.0 ± 0.4</p> <p><u>PAL^{NASG}:</u></p> <p>DIET: pre-WL > WL* CT: pre-WL = WL</p>	<p><u>Energy intake (kcal/kg/d)^{NASG}:</u></p> <p>DIET: 35 ± 10 CT: 31 ± 8</p> <p><u>CHO (g/kg/d)^{NASG}:</u></p> <p>DIET: 3.9 ± 1.0 CT: 3.5 ± 1.3</p> <p><u>Lip (g/kg/d)^{NASG}:</u></p> <p>DIET: 1.4 ± 0.5 CT: 1.2 ± 0.2</p> <p><u>Prot (g/kg/d)^{NASG}:</u></p> <p>DIET: 1.6 ± 0.5 CT: 1.5 ± 0.4</p> <p><u>Fluid intake (water) (L)^{NASG}:</u></p> <p>DIET: 2.5 ± 0.9 CT: 1.9 ± 0.9</p> <p><u>PAL^{NASG}:</u></p> <p>DIET: WL* > WG#* CT: NS between each time points</p>	<p>[pre-WL / WL / WG] <u>BW (kg)^{NASG}:</u></p> <p>DIET: 67.4 ± 9.4 / 63.7 ± 9.3* / 66.9 ± 9.5 CT: 64.8 ± 8.9 / 65.0 ± 9.5 / 64.9 ± 9.4</p> <p><u>FM (%BW)^{NASG}:</u></p> <p>DIET: 8.7 ± 1.7 / 8.2 ± 1.6 / 8.5 ± 1.6 CT: 9.5 ± 2.1 / 9.5 ± 2.0 / 9.5 ± 2.1</p> <p><u>FFM (kg)^{NASG}:</u></p> <p>DIET: 61.4 ± 8.1 / 58.4 ± 8.1* / 61.2 ± 8.1 CT: 58.5 ± 7.1 / 58.7 ± 7.5 / 58.7 ± 7.5</p>
99 BJJ [115]	<p><u>Usual WL methods:</u> see Table 1</p> <p><u>Usual WL duration (% of sample):</u> 0-2 d (16%); 3-7 d (34%); 8-14 d (31%); 15-21 d (6%); 22-30 d (7%); >31 d (6%)</p>	NR	<u>Usual weight variations:</u> see Table 1

Ref sport group [n]	WL period conditions (food intake, physical activity and other methods)	WG period conditions (food intake, physical activity and other methods)	Main BW and body composition results
38 Judo WC [14] WCsub [4] CT [7]	WC: <u>Energy intake (kcal/kg/d):</u> 19.6 ± 4.4 <u>CHO (g/kg/d):</u> 2.7 ± 0.8 <u>Lip (g/kg/d):</u> 0.5 ± 0.1 <u>Prot (g/kg/d):</u> 1.0 ± 0.3	WC: <u>Energy intake (kcal/4h):</u> 1391 ± 375 <u>CHO (g/4h):</u> 201 ± 62 <u>Lip (g/4h):</u> 50 ± 16 <u>Prot (g/4h):</u> 34 ± 23	[pre-WL / WL / WG] <u>BW (kg):</u> WC: 77.9 ± 12.2 / 74.1 ± 11.4* (-4.8 + 1.1% from pre-WL) / NR (51 ± 13% of the weight lost was regained) WCsub: 72.56 ± 7.99 / 69.09 ± 7.90 / 70.83 ± 8.28 CT: 67.3 ± 5.8 / 67.4 ± 5.8 / NR <u>FM (kg):</u> WC: 8.8 ± 2.6¶ / 8.0 ± 2.3*¶ / NR WCsub: 11.63 ± 2.94 / 11.05 ± 2.86 / NR CT: 4.0 ± 1.6¶ / 4.2 ± 1.7¶ / NR <u>FFM (kg):</u> WC: 66.2 ± 4.6 / 63.5 ± 4.9* / NR CT: 63.3 ± 5.1 / 63.2 ± 5.1 / NR
12 Judo WC [688]	WC: <u>Usual WL methods and duration:</u> see Table 1	NR	WC: <u>Season weight (kg):</u> 70 ± 17.5 <u>Inter-season weight and usual weight variations:</u> see Table 1 <u>WG during the week after the competition (% of sample):</u> 0-1.5 kg: 50%, 1.6-3 kg: 40% and >3 kg: 10%
86 Judo WC [9] CT [9]	[pre-WL / WL-1 (food restriction not yet started)] <u>Energy intake (kcal/d):</u> WC: 2137 ± 608 / 2444 ± 1154 CT: 2644 ± 590 / 2773 ± 798 <u>CHO (g/d):</u> WC: 245.8 ± 98.4 (47.6 ± 12.0%EI) / 298.5 ± 168 (48.6 ± 10.7%EI) CT: 342.8 ± 84.5 (52.9 ± 7.2%EI) / 321.5 ± 97.0 (49.8 ± 7.0%EI) <u>Lip (g/d):</u> WC: 70.0 ± 29.1 (32.5 ± 10.5%EI) / 88.0 ± 44. (32.1 ± 6.4%EI) CT: 93.3 ± 28.8 (31.7 ± 5.5%EI) / 96.9 ± 35.2 (33.0 ± 5.5%EI) <u>Prot (g/d):</u> WC: 91.0 ± 33.6 (17.4 ± 4.4%EI) / 99.3 ± 47.7 (18.1 ± 6.0%EI) CT: 105 ± 30.9 (15.3 ± 2.1%EI) / 116.9 ± 40.0 (17.5 ± 4.0%EI)	<u>Energy intake (kcal/d):</u> WC: 2270 ± 1219 CT: 2648 ± 352 <u>CHO (g/d):</u> WC: 238.4 ± 121.8 (42.9 ± 11.0%EI) CT: 307.9 ± 37.2 (47.6 ± 5.0%EI) <u>Prot (g/d):</u> WC: 98.1 ± 46.7 (21.0 ± 10.0%EI) CT: 116.5 ± 28.9 (18.4 ± 2.7%EI) <u>Lip (g/d):</u> WC: 85.7 ± 44.6 (35.6 ± 10.5%EI) CT: 91.3 ± 20.3 (31.4 ± 2.8%EI)	[pre-WL / WL-1 / WL-2 / WG] <u>BW (kg):</u> WC: 81.8 ± 12.3 / 81.3 ± 11.8 / 77.1 ± 11.9* / 81.6 ± 10.8 CT: 85.1 ± 12.4 / 86.1 ± 13.1 / 87.7 ± 16.9 / 86.5 ± 13.9 <u>FM (%BW):</u> WC: 16.2 ± 4.5 / 15.5 ± 4.6 / NR / 14.6 ± 6.5 CT: 14.4 ± 3.4 / 15.5 ± 3.0 / NR / 16.5 ± 3.4 <u>FFM (kg):</u> WC: 68.2 ± 8.2 / 68.5 ± 8.2 / NR / 67.5 ± 7.9 CT: 72.6 ± 9.5 / 72.6 ± 10.2 / NR / 72.1 ± 10.9
	[WL-2] WC: food restriction (food intake: NR)		

Ref sport group [n]	WL period conditions (food intake, physical activity and other methods)	WG period conditions (food intake, physical activity and other methods)	Main BW and body composition results
87 Judo LEI [6] VLEI [6] CT [6]	[pre-WL / WL-1 / WL-2] <u>Energy intake (kcal/d):</u> LEI: 3182 ± 258 / 2579 ± 301* / 2387 ± 385* μ VLEI: 2530 ± 284 / 2028 ± 322* μ / 1796 ± 478* μ CT: 3272 ± 994 / 2877 ± 384 μ / 3291 ± 361 μ Separation between groups with the median energy intake <u>Physical activity:</u> - running and weight training: 1 h/d - judo training: 2.5 h/d	<u>Energy intake (kcal/d):</u> LEI: 2974 ± 467 VLEI: 2537 ± 400 μ CT: 3285 ± 427 μ	[pre-WL / WL-1 / WL-2 / WG] <u>BW (kg):</u> LEI: 74.7 ± 5.6 kg / 73.7 ± 5.4 kg* / 72.0 ± 6.3 kg* (-3.6% from pre-WL) / 74.5 ± 4.9 kg VLEI: 74.3 ± 6.2 kg / 72.8 ± 6.5 kg* / 71.0 ± 6.9 kg* (-4.4% from pre-WL) / 73.3 ± 5.1 kg CT: 75.0 ± 5.7 kg / 74.9 ± 5.6 kg / 74.3 ± 6.0 kg* / 74.4 ± 5.8 kg <u>FM (%BW):</u> LEI: 10.6 ± 5.2 / 9.4 ± 5.0 / 9.3 ± 4.6* / 8.8 ± 4.5* VLEI: 11.5 ± 5.4 / 11.0 ± 5.6 / 10.2 ± 4.9 / 9.2 ± 6.3 CT: 9.6 ± 4.5 / 10.4 ± 4.3* / 10.8 ± 5.0 / 9.3 ± 5.3 <u>FM (kg):</u> LEI: 8.1 ± 4.6 / 7.1 ± 4.1 / 6.9 ± 4.0* / 6.7 ± 3.8* VLEI: 8.7 ± 4.6 / 8.3 ± 4.6 / 7.5 ± 4.1 / 7.0 ± 5.0* CT: 7.4 ± 3.9 / 7.9 ± 3.8 / 8.2 ± 4.3 / 7.2 ± 4.4 <u>FFM (kg):</u> LEI: 66.6 ± 1.5 / 66.6 ± 2.3 / 65.1 ± 2.5 / 67.5 ± 1.7 VLEI: 65.6 ± 4.4 / 64.5 ± 3.7 / 63.5 ± 4.0* / 66.5 ± 3.5 CT: 67.5 ± 2.4 / 66.8 ± 2.6 / 66.0 ± 2.2* / 67.2 ± 2.4
88 Judo total [10] slight WL [5] marked WL [5]	[pre-WL / WL-1 / WL-2] <u>Energy intake (kcal/d):</u> total: 2747 ± 1212 / 2249 ± 890 / 930 ± 708* slight WL: 2443 ± 1204 / 2369 ± 896 / 644 ± 675* marked WL: 3052 ± 111 / 2128 ± 713 / 1216 ± 620* <u>CHO (g/d):</u> total: 446 ± 210 (65.5 ± 9.0%EI) / 340 ± 142 (62.0 ± 3.1%EI) / 153 ± 116* (66.2 ± 4.7%EI) slight WL: 369 ± 178 (60.9 ± 5.6%EI) / 343 ± 144 (59.4 ± 3.3%EI) / 124 ± 135* (77.8 ± 5.8%EI) marked WL: 522.2 ± 203.5 (69.2 ± 6.6%EI) / 338 ± 120 (64.8 ± 5.6%EI) / 182 ± 82* (60.1 ± 6.6%EI) <u>Lip (g/d):</u> total: 68.8 ± 39.9 (22.8 ± 5.4%EI) / 61.1 ± 50.7 (25.0 ± 2.8%EI) / 25.4 ± 27.7* (24.7 ± 2.8%EI) slight WL: 72.0 ± 46.3 (26.7 ± 2.7%EI) / 69.9 ± 57.9 (27.2 ± 2.8%EI) / 9.3 ± 8.7* (13.2 ± 5.5%EI*) marked WL: 65.7 ± 31.8 (19.4 ± 2.2%EI) / 52.4 ± 35.3 (22.6 ± 5.6%EI) / 41.5 ± 30.7* (30.8 ± 3.5%EI*) <u>Prot (g/d):</u> total: 79.6 ± 40.9 (11.7 ± 2.4%EI) / 71.5 ± 30.8 (13.0 ± 3.5%EI) / 21.0 ± 17.5* (9.1 ± 2.5%EI) slight WL: 74.5 ± 37.2 (12.3 ± 2.0%EI) / 77.2 ± 31.2 (13.4 ± 3.9%EI) / 14.3 ± 14.1* (9.0 ± 2.1%EI) marked WL: 84.8 ± 42.4 (11.2 ± 2.2%EI) / 65.7 ± 24.8 (12.6 ± 4.4%EI) / 27.7 ± 18.1* (9.1 ± 2.3%EI)	<u>Energy intake (kcal/d):</u> total: 3278 ± 226 slight WL: 2323 ± 546 marked WL: 3855 ± 2476 <u>CHO (g/d):</u> total: 503 ± 366 (62.4 ± 2.8%EI) slight WL: 359 ± 103 (62.6 ± 5%EI) marked WL: 609 ± 430 (64.6 ± 9%EI) <u>Lip (g/d):</u> total: 92.1 ± 60.3 (25.7 ± 2.7%EI) slight WL: 65.4 ± 29.6 (25.7 ± 3.2%EI) marked WL: 98.3 ± 53.8 (23.5 ± 6.6%EI) <u>Prot (g/d):</u> total: 95.5 ± 70.0 (11.8 ± 2.9%EI) slight WL: 67.0 ± 19.8 (11.7 ± 3.3%EI) marked WL: 112.1 ± 69.6 (11.9 ± 3.2%EI)	[pre-WL / WL-1 / WL-2 / WG] <u>BW (kg):</u> total: 73.9 ± 11.1 / 72.3 ± 10.3 / 69.7 ± 10.8* / 72.6 ± 10.0 slight WL: 79.0 ± 12.2 / 77.9 ± 11.1 / 75.2 ± 12.2 / 77.2 ± 11.2 marked WL: 68.8 ± 10.1 / 66.7 ± 9.9 / 64.2 ± 8.7* / 68.0 ± 8.2 <u>FM (%BW):</u> total: 11.7 ± 5.4 / 7.9 ± 4.8 / 6.6 ± 5.0* / 8.4 ± 4.8 slight WL: 14.0 ± 5.8 / 13.4 ± 4.3 / 12.1 ± 4.6 / 14.0 ± 4.3 marked WL: 9.4 ± 3.7 / 7.0 ± 2.3 / 5.3 ± 3.0* / 8.1 ± 2.6 <u>FM (kg):</u> total: 9.2 ± 5.7 / 10.2 ± 4.7 / 8.7 ± 5.2 / 11.1 ± 4.6 slight WL: 11.1 ± 6.2 / 10.4 ± 5.1 / 9.1 ± 6.1 / 10.8 ± 5.8 marked WL: 6.5 ± 4.7 / 4.7 ± 4.5 / 3.4 ± 4.4* / 5.5 ± 3.8 <u>FFM (kg):</u> total: 64.6 ± 5.9 / 64.3 ± 5.9 / 63.1 ± 6.2 / 64.1 ± 5.8 slight WL: 67.6 ± 5.9 / 66.8 ± 5.7 / 65.4 ± 6.6 / 65.9 ± 6.6 marked WL: 61.6 ± 4.2 / 61.9 ± 4.9 / 60.7 ± 4.6 / 62.3 ± 4.3

Ref sport group [n]	WL period conditions (food intake, physical activity and other methods)	WG period conditions (food intake, physical activity and other methods)	Main BW and body composition results
56 Judo judo m [22] judo f [26] WC [19] WC m [9] WC f [26] CT m [13] CT f [16] AS m [8] AS f [12]	WL method: food restriction WL duration: 1 wk before competition	NR	[pre-WL / WL / WG] BW (kg): judo m: 73.6 ± 8.3 kg / NR / NR judo f: 60.3 ± 9.1 kg / NR / NR WC: NR / -4 ± 0.3% from pre-WL / +4 ± 0.5% from WL FM (%BW): judo m: 11.6 ± 3.6 / NR / NR judo f: 23 ± 4.1¶ / NR / NR WC m: 11.6 ± 3.9 / 10.9 ± 3.3 / 11.1 ± 3.3 WC f: 22.8 ± 3.5 / 22.1 ± 3.5 / 21.4 ± 3.5 CT m: 11.6 ± 4.0 / 11.9 ± 3.2 / 12 ± 3.2 CT f: 23.1 ± 4.4 / 22.7 ± 3.6 / 22.7 ± 4 AS m: 14.2 ± 4.4 / NR / NR AS f: 28.1 ± 5.1¶ / NR / NR FFM (kg): judo m: 61.6 ± 5.8 / NR / NR judo f: 43.7 ± 5.1¶ / NR / NR WC m: 64.9 ± 5.4 / 62.7 ± 5.7* / 65.2 ± 5.4 WC f: 44.6 ± 4.4 / 43.4 ± 4.4* / 45.0 ± 4.4 CT m: 59.3 ± 5.0 / 59.4 ± 4.7 / 59.8 ± 4.7 CT f: 43.3 ± 5.6 / 43.5 ± 5.6 / 43.7 ± 5.6 AS m: 59.0 ± 6.5 / NR / NR AS f: 38.3 ± 4.6¶ / NR / NR
57 Judo m [22] f [26] WC [19]	[pre-WL] Energy intake (kcal/d): m: 2960 ± 633.2¶ f: 2121 ± 673.1¶ CHO (g): m: 362 ± 98.5¶ (50 ± 9.4%EI) f: 245 ± 86.7¶ (47 ± 5.1%EI) Lip (g): m: 124 ± 46.9¶ (37 ± 9.4%EI) f: 93 ± 35.7¶ (39 ± 5.1%EI) Prot (g): m: 94 ± 28.1¶ (13 ± 2.3%EI) f: 66 ± 15.3¶ (13 ± 2.5%EI)	NR	[pre-WL] BW (kg) ^{NAS} : m: 73.6 ± 8.3 f: 60.3 ± 9.1 FM (%BW) ^{NAS} : m: 11.6 ± 3.6 f: 23 ± 4.1 FFM (kg) ^{NAS} : m: 61.6 ± 5.8 f: 43.7 ± 5.1 [WL/WG] Weight variations (%) ^{NAS} : WC: -4 ± 0.3 / +4 ± 0.5

Ref sport group [n]	WL period conditions (food intake, physical activity and other methods)	WG period conditions (food intake, physical activity and other methods)	Main BW and body composition results
58 Judo WC [19] WC m [9] WC f [10] CT m [13] CT f [16]	NR	NR	[pre-WL / WL / WG] <u>BW (kg):</u> WC: NR / -4 ± 0.3% from pre-WL / +4 ± 0.5% from WL WC m: 77.7 ± 8.2¶ / NR / NR WC f: 70.7 ± 7.6¶ / NR / NR <u>FM (%BW)^{NASG}:</u> WC m: 11.6 ± 3.9 / 10.9 ± 3.3 / 11.1 ± 3.3 WC f: 22.8 ± 3.5 / 22.1 ± 3.5 / 21.4 ± 3.5 CT m: 11.6 ± 4.0 / 11.9 ± 3.2 / 12 ± 3.2 CT f: 23.1 ± 4.4 / 22.7 ± 3.6 / 22.7 ± 4 <u>FM (kg)^{NASG}:</u> WC m: 9.3 ± 4.1 / 8.2 ± 3.1 / 8.8 ± 2.9 WC f: 14.1 ± 3.4 / 13.2 ± 3.4* / 13.1 ± 12.5 CT m: 8.5 ± 3.5 / 8.7 ± 3.1 / 8.9 ± 3.2 CT f: 14.2 ± 5.3 / 13.8 ± 4.3 / 13.9 ± 4.3 <u>FFM (kg)^{NASG}:</u> WC m: 64.9 ± 5.4 / 62.7 ± 5.7* / 65.2 ± 5.4 WC f: 44.6 ± 4.4 / 43.4 ± 4.4* / 45.0 ± 4.4 CT m: 59.3 ± 5.0 / 59.4 ± 4.7 / 59.8 ± 4.7 CT f: 43.3 ± 5.6 / 43.5 ± 5.6 / 43.7 ± 5.6
63 Judo total [86] m [50] f [36] winners [44] losers [42]	NR	NR	[WL / WG] <u>BW (kg)^{NASG}:</u> total: 66.5 ± 12.3 / 68.2 ± 12.4 (+2.6 ± 2.1%) m: 72.1 ± 11.4 / 73.8 ± 11.7# (+2.3 ± 2.1%) f: 58.7 ± 8.6 / 60.5 ± 8.8# (+3.1 ± 2.1%) winners: NR / NR (+3.6 ± 2.0%¶) losers: NR / NR (+2.1 ± 2.0%¶)
89 Judo DIET [8] CT [8]	[pre-WL / WL] <u>Energy intake (kcal/d):</u> DIET: 2450.0 ± 543.3 / 1071.4 ± 255.7* CT: 1864.6 ± 518.4 / 1599.5 ± 811.8	<u>Energy intake (kcal/d):</u> DIET: 1689.5 ± 555.9* CT: 1765.9 ± 626.9	[pre-WL / WL / WG] <u>BW (kg (% from pre-WL)):</u> DIET: 65.5 ± 12.0 / 62.3 ± 12.0* (-4.9 ± 2.7%¶) / 64.4 ± 11.8* (-1.6 ± 1.9%) CT 64.8 ± 8.4 / 64.5 ± 8.1 (-0.5 ± 1.1%¶) / 65.0 ± 7.9 (+0.3 ± 1.8%)
90 MMA WC [29]	WC WL methods: see Table 1	NR	WC Usual weight variations: see Table 1

Ref sport group [n]	WL period conditions (food intake, physical activity and other methods)	WG period conditions (food intake, physical activity and other methods)	Main BW and body composition results
2 MMA winners [8] losers [7]	<p>Energy intake (median [IR25-IR75], kcal): winners: 745.5 [103.5-1104.5] losers: 303.0 [159.4-702.8]</p> <p>CHO (median [IR25-IR75], g/d): winners: 79.8 [26.3-166.7] (49.0 [21.6-64.8]%EI) losers: 20.0 (1.2, 96.5) (27.1 (3.1, 55.4)%EI)</p> <p>Prot (median [IR25-IR75], g/d): winners: 18.3 [1.2-60.4] (9.0 [3.1-23.1]%EI) losers: 17.0 [11.7- 30.3] (18.7 [12.8-30.6]%EI)</p> <p>Lip (median [IR25-IR75], g/d): winners: 18.2 [0.5-36.8] (13.9 [3.2-32.0]%EI) losers: 12.9 [8.7-14.9] (27.4 [18.5-47.2]%EI)</p> <p>Usual WL methods: exercise practices > restriction of liquid ingestion > plastic clothing > wearing hot clothes > spitting > sauna > laxatives > diuretics > skipping meals > all-day fasting</p> <p>Usual WL duration: see Table 1</p>	<p>Energy intake (median [IR25-IR75], kcal/d): winners: 5191.5 [2887.0-6117.0]# losers: 2952.1 [2166.5- 4722.1]#</p> <p>CHO (median [IR25-IR75], g/d): winners: 610.6 [374.2-663.2]# (45.8 [43.2-50.0]%EI) losers: 299.1 [224.8-492.2]# (35.6 [30.0-50.4]%EI)</p> <p>Prot (median [IR25-IR75], g/d): winners: 250.2 [184.1-347.1]# (21.5 [17.5-26.0]%EI#) losers: 224.3 [160.9-298.6]# (20.0 [18.3-39.0]%EI)</p> <p>Lip (median [IR25-IR75], g/d): winners: 170.3 [105.7-205.9]# (31.1 [26.3-34.5]%EI) losers: 116.1 [73.2-194.7]# (37.5 [21.8-44.0]%EI)</p>	<p>[pre-WL / WL / WG] BW (kg)^{NAS}: 89.9 ± 17.3 / 83.2 ± 16.3 / 87.3 ± 16.9</p> <p>Weight variations (% of BW): winners: N/A / -6.8 ± 5.5 / +6.1 ± 3.3¶ losers: N/A / -7.3 ± 2.4 / +2.4 ± 1.1¶</p>
64 MMA [40]	NR	NR	<p>[WL / WG] BW (kg): 75.8 ± 1.5 / 79.2 ± 1.6# (+4.4%) FM (%BW): 13.4 ± 0.5 / NR</p>
79 MMA [1]	<p>[pre-WL / WL-1 / WL-2 / WL-3 / WL-4 / WL-5 / WL-6 / WL-7 / WL-8]</p> <p>Energy intake (kcal/d): 1592 ± 289 / 1378 ± 150 / 1055 / 1050 / 1070 / 1065 / 1075 / 682 / 0</p> <p>CHO (g/kg/d): NR / 1.5-2.5 / 1.5-2.5 / 0.5 / 0.5 / 0.5 / 0.5 / 0</p> <p>Lipid (g/kg/d): NR / 0.8-1 / 0.8-1 / 0.5 / 0.5 / 0.5 / 0.5 / 0</p> <p>Prot (g/kg/d): NR / 1.6-1.8 / 1.6-1.8 / 1.3 / 1.3 / 1.3 / 1.3 / 0</p> <p>Fibre (g/d): NR / 18.4 / 18.4 / 5.6 / 5.6 / 5.6 / 5.6 / 5.6 / 0</p> <p>Sodium intake (g/d): NR / 2.9 / 2.9 / 0.3 / 0.3 / 0.3 / 0.3 / 0</p> <p>Fluid intake (mL/d): NR / NR / 7030 / 8020 / 8168 / 8020 / 8069 / 916 / 0</p> <p>Physical activity: - pre-WL to WL-2 (per wk): 2 strength and conditioning sessions + 8 combat specific training sessions + 2 sparring sessions - WL-7 to WL-8: 6 hot water baths + 6 wraps</p>	<p>[WG-1] CHO (g/kg/d): 15 Lipid (g/kg/d): 2.6 Prot (g/kg/d): 3.2 Fibre (g/d): 63 Sodium intake (g/d): 8.5</p>	<p>[pre-WL / WL-1 / WL-2 / WL-3 / WL-4 / WL-5 / WL-6 / WL-7 / WL-8 / WG-1 / WG-2] BW (kg): 80.2 / 77.8 / 75.8 / NR / 77.0 / 75.5 / 74.7 / 73.0 / 65.7 / 77.0 / 83.6 FM (%BW): 15.0 / 12.6 / 10.6 / NR / NR / NR / NR / NR / 11.0 / NR / 12.2 FM (kg): 11.7 / 9.4 / 7.7 / NR / NR / NR / NR / NR / 6.9 / NR / 9.7 FFM (kg): 63.5 / 65.2 / 65.0 / NR / NR / NR / NR / NR / 53.6 / NR / 67.2</p>
91 MMA [7]	<p>Energy intake (kcal/d): 1261 ± 725</p> <p>CHO (g/d): 68 ± 82</p> <p>Usual WL methods: see Table 1</p> <p>Other WL methods (% of sample, sum of 'always' and 'sometimes' answers): - Hot salt baths: 85% - Fat burner supplements: 28%</p>	<p>Energy intake (kcal/d): 3176 ± 482#</p> <p>CHO (g/d): 471 ± 124#</p>	<p>[pre-WL / WL / WG] BW (kg): 69.9 ± 5.7 / 64.5 ± 5.2* (-8.0 ± 1.8% from pre-WL) / 71.8 ± 5.4# (+11.7 ± 4.7% from WL)</p>
61 MMA m [455] f [57]	NR	NR	<p>[WL / WG] BW (kg): m: 72.2 ± 12.2 / 77.7 ± 11.9# (+8.1 ± 3.6%) f: 56.0 ± 6.2 / 60.4 ± 7.3# (+8.0 ± 3.8%)</p>
3 Sambo [199]	Usual WL methods and duration: see Table 1	NR	Current weight and usual weight variations: see Table 1

Ref sport group [n]	WL period conditions (food intake, physical activity and other methods)	WG period conditions (food intake, physical activity and other methods)	Main BW and body composition results
13 <u>Sambo</u> [103]	Usual WL methods and duration: see Table 1	NR	Current weight and usual weight variations: see Table 1
11 TKD WC [94]	WC Usual WL methods and duration: see Table 1	NR	WC Inter-season weight and usual weight variations: see Table 1
92 TKD [16]	[WL-1 / WL-2 / WL-3] Physical activity (% technique training + % physical training): 70-80% + 20-30% / 90% + 10% / 100% + 0%	[WG-1 / WG-2 / WG-3] Physical activity (h/d regular training): 0 h / 2 h / 4 h	[pre-WL / WL-1 / WL-2 / WL-3 / WG-1 / WG-2 / WG-3] BW (kg): 71.2 ± 10.4# / 71.5 ± 9.9# / 70.7 ± 9.6# / 69.8 ± 9.2* / 71.4 ± 9.8# / 71.4 ± 9.8# / 71.5 ± 10.0# FM (%BW): 16.4 ± 4.9# / 16.8 ± 4.8 / 17.1 ± 4.9* / 17.5 ± 4.5* / 17.9 ± 4.3* / 18.3 ± 4.6*# / 18.8 ± 4.7*# FM (kg): 12.0 ± 5.3 / 12.3 ± 5.1* / 12.5 ± 5.3 / 12.2 ± 4.9 / 13.1 ± 4.8*# / 13.4 ± 5.0 / 13.8 ± 5.1*#
65 <u>Wrestling</u> [8]	NR	NR	[WL / WG-1 / WG-2 / WG-3] BW (kg): 73.7 ± 9.9 / 75.8 ± 9.5# / 77.8 ± 9.1# / 78 ± 9.3#
66 <u>Wrestling winners</u> [266] losers [269]	NR	NR	[WL / WG] Weight evolution (kg from WL): winners: N/A / +3.5 ± 1.2 (+5.3 ± 2.0%) losers: N/A / +3.5 ± 1.5 (+5.3 ± 2.4%)
93 <u>Wrestling</u> [12]	[pre-WL / WL-1 / W-2] Food intake (g/d): 4498 ± 989 / 3573 ± 1016* / 122 ± 201* Water intake (g/d): 3740 ± 509 / 2954 ± 664* / 128 ± 110*	[WG-1] Food intake (g/d): 6589 ± 1383* Water intake (g/d): 5536 ± 910*	[pre-WL / WL-1 / WL-2 / WG-1 / WG-2] BW (kg (% from pre-WL)): 74.5 ± 9.2 / 74.3 ± 9.4 (-0.4%) / 69.1 ± 9.0* (-7.3%) / 72.2 ± 9.3* (-3.3%) / 74.1 ± 9.9 (-1.1%) FM (%BW (% from pre WL)): 15.1 ± 2.8 / 14.4 ± 3.1 (-5.1%) / 13.8 ± 3.1* (-9.3%) / 13.7 ± 3.4* (-10.7%) / 15.6 ± 3.5 (+2.5%) FFM (kg (% from pre-WL)): 59.8 ± 6.3 / 60 ± 6.4 (+0.4%) / 56.2 ± 6.0* (-5.9%) / 58.7 ± 6.2* (-1.6%) / 59.4 ± 6.4 (-0.8%) TBW (kg (% from pre-WL)): 43.8 ± 4.6 / 44 ± 4.7 (+0.4%) / 41.2 ± 4.4* (-5.9%) / 43.0 ± 4.6* (-1.6%) / 43.5 ± 4.7 (-0.8%)
67 <u>Wrestling</u> [13]	[pre-WL-2 / WL-1 / WL-2 / WL-3 / WL-4 / WL-5] Energy intake (kcal/d): - week 1: 2256 ± 433 / 1962 ± 341 / 1943 ± 321 / 1778 ± 302 / 1325 ± 256\$ / 924 ± 131\$ - week 2: 3045 ± 262 / 2743 ± 210 / 2402 ± 158 / 2540 ± 420 / 1726 ± 282\$ / 874 ± 210\$ - week 1 & 2: average intake (2194) < estimated intake (3140) Fluid intake (L/d): - week 1: 2.2 ± 0.4 / 2.4 ± 0.3 / 2.5 ± 0.4 / 2.7 ± 0.5 / 1.9 ± 0.3 / 1.2 ± 0.2\$ - week 2: 2.2 ± 0.2 / 2.9 ± 0.4 / 2.8 ± 0.4 / 2.9 ± 0.6 / 2.3 ± 0.4\$ / 1.5 ± 0.4 - week 1 & 2: average intake (2.6) < estimated intake (6.5) Usual WL methods and duration: see Table 1	Energy intake on competition day (kcal/d): - week 1: 4082 ± 367\$ - week 2: 3361 ± 321\$ Fluid intake (L/d): - week 1: 5.0 ± 0.5\$ - week 2: 4.7 ± 0.5\$	[pre-WL-2 / WL-1 / WL-2 / WL-3 / WL-4 / WL-5] BW week 1 & 2(kg): 73.9 / 73.9 / 73.8 / 73.3\$ / 72.1\$ / 70.9\$ (-4.7% of pre-WL) WL for the first meet of the season (% from pre-WL-1): -5.3% Weight variations (% of the sample): - lose and regain > 2.3 kg during a typical week: 62% - lose and regain > 4.6 kg during a typical week: 8% [WG] FM variations (% from pre-WL-1) ^{NAS} : - bioimpedance: -1.1 ± 0.7 - underwater weighing: -2.9 ± 2.1 FM variations (kg from pre-WL-1): - bioimpedance: -0.9 - underwater weighing: -2.2* FFM variations (kg from pre-WL-1): - bioimpedance: +0.3 - underwater weighing: 1.8 ± 1.5*

Ref sport group [n]	WL period conditions (food intake, physical activity and other methods)	WG period conditions (food intake, physical activity and other methods)	Main BW and body composition results
74 <u>Wrestling</u> WC [8] CT [6]	[WL-1] <u>Energy intake (kcal/d):</u> WC: 2305.4 ± 678.5¶ CT: 3270.6 ± 740.6¶ <u>CHO (%EI):</u> WC: 54 ± 7 CT: 53 ± 11 <u>Lip (%EI):</u> WC: 29 ± 6 CT: 28 ± 6 <u>Prot (%EI):</u> WC: 16 ± 3 CT: 16 ± 3	NR	[pre-WL / WL-1 / WL-2 / WG] <u>BW (kg):</u> WC: 72.4 ± 11.9 / 70.9 ± 11.6 / 66.1 ± 12.4* / 73.9 ± 10.5*# CT (n=5): 74.9 ± 8.9 / 75.8 ± 8.7 / 76.4 ± 8.7 / 78.4 ± 11.9 ΔWL-2-WL-1: WC > CT
68 <u>Wrestling</u> total [51] DIET [27] CT [24]	NR	NR	[WL / WG] <u>BW and weight variations from previous time point (kg):</u> total: 75.4 ± 13.8 / 77.0 ± 13.3# (+2.3 ± 2.2%) DIET: 72.1 ± 9.0 / 74.6 ± 8.6# (+3.5 ± 1.9%¶) CT: 79.0 ± 17.2 / 79.7 ± 16.8# (+1.0 ± 1.8%¶) <u>Weight management:</u> DIET: -4.3 ± 2.0 kg within 7.8 ± 5.6 d
14 <u>Wrestling</u> total [741] LW [NR] MW [NR] HW [NR] D1 [275] D2 [167] D3 [299]	Usual WL methods and duration: see Table 1	NR	[pre-WL / WL / WG] <u>BW and weight variations from the previous time point (kg)^{NAS†}:</u> total: 73.2 ± 10.2 / -2.9 ± 1.3 (-4.3 ± 2.2%) / +5.5 ± 3.5 (+8.6 ± 5.4%) LW: 63.8 ± 4.5 / -3.0 ± 1.3 (-5.0 ± 2.2%¶) / +5.8 ± 3.4 (+9.8 ± 2.9%μ) MW: 74.7 ± 4.4 / -3.0 ± 1.4 (-4.1 ± 2.0%¶) / +6.1 ± 3.5 (+8.5 ± 4.9%μ) HW: 86.6 ± 6.6 / -2.7 ± 1.2 (-3.2 ± 1.6%¶) / +5.4 ± 3.8 (+6.5 ± 4.5%μ) D1: 72.4 ± 9.9 / -2.8 ± 3.0£ (-4.2 ± 2.0%£) / +5.3 ± 3.0£ (+8.1 ± 5.2%£) D2: 73.9 ± 9.4 / -3.4 ± 1.5£§ (-4.9 ± 2.4%£§) / +6.3 ± 1.4£§ (+9.7 ± 5.4%£§) D3: 73.6 ± 11.0 / -2.8 ± 3.3§ (-4.0 ± 2.4%§) / +5.3 ± 3.8§ (+8.4 ± 5.6%§)
72 <u>Wrestling</u> total [811] LW [315] MW [290] HW [206] D1 [385] D2 [195] D3 [231]	NR	NR	[pre-WL / WL / WG] <u>BW and weight variations from the previous time point (kg):</u> total: NR / -1.2 ± 0.9* (-1.7 ± 1.2%*) / +0.9 ± 0.8# LW: NR / NR (-1.9 ± 13%¶) / +1.0 ± 0.8 (+1.7 ± 1.3%μ) MW: NR / NR (-1.7 ± 1.1%) / +0.8 ± 0.8 (+1.2 ± 1.1%μ) HW: NR / NR (-1.5 ± 1.1%¶) / +0.7 ± 0.8 (+0.8 ± 1.0%μ) D1: 73.3 / 71.3* (-1.9 ± 1.3%) / NR (+1.4 ± 1.2%) D2: 75.2 / 71.8* (-1.6 ± 1.0%) / NR (+1.4 ± 1.3%) D3: 74 / 71.5* (-1.3 ± 1.2%) / NR (+0.9 ± 1.2%) <u>FM (%BW):</u> D1: 11.6 / 9.1* / NR D2: 13.8 / 10.1* / NR D3: 12.3 / 9.6* / NR
75 <u>Wrestling</u> [78]	NR	NR	[pre-WL / WL-1 / WL-2 / WG-1 / WG-2 / WG-3 / WG-4] <u>BW (kg):</u> 76 / 73.93 ± 11.62 / 72.53 ± 11.66\$ / 73.65 ± 13.58\$ / 74.1 ^{NAS} / 75.3 ^{NAS} / 78.2 ^{NAS} <u>FM (%BW)^{NAS}:</u> 13.1 ± 10.2 / NR / 10.0 ± 2.6 / NR / 9.7 ± 2.2 / 9.6 ± 2.1 / 10.6 ± 2.6

Ref sport group [n]	WL period conditions (food intake, physical activity and other methods)	WG period conditions (food intake, physical activity and other methods)	Main BW and body composition results
69 <u>Wrestling total</u> [668] <u>non-HW</u> [607] <u>LW</u> [68] <u>D1</u> [333] <u>D2</u> [137] <u>D3</u> [198]	NR	NR	[WL / WG] <u>BW (kg):</u> <u>LW:</u> 53.5 ± 0.1 / 56.9 ± 1.2# <u>Weight variations (kg):</u> <u>total:</u> N/A / +3.3 ± 1.5# (+4.9 ± 2.4%) → 95% of the sample gained ≥ 0.5 kg <u>D1:</u> N/A / +3.4 ± 1.6# (+5.1 ± 2.5%) <u>D2:</u> N/A / +3.0 ± 1.3# (+4.5 ± 2.2%) <u>D3:</u> N/A / +3.2 ± 1.5# (+4.8 ± 2.5%) <u>non-HW:</u> N/A / +3.7 ± 1.3# (+5.3 ± 2.2%) → 95% of the sample gained ≥ 1.4 kg
4 <u>Wrestling collegiate</u> [63]	<u>collegiate:</u> <u>Usual WL methods and duration:</u> see Table 1 <u>Preoccupation with food (% of sample, sum of ‘always’ and ‘sometimes’ answers):</u> 95% <u>Frequency of dieting (% of sample, sum of ‘always’ and ‘sometimes’ answers):</u> 92%	<u>collegiate:</u> <u>Preoccupation with food (% of sample, sum of ‘always’ and ‘sometimes’ answers):</u> 47% <u>Frequency of dieting (% of sample, sum of ‘always’ and ‘sometimes’ answers):</u> 22%	<u>collegiate:</u> <u>Usual weight variations:</u> see Table 1 <u>Weight gain post-season (kg):</u> 7.6 ± 3.1 <u>Weekly weight fluctuation (% of sample):</u> - 0-1 kg: 21% - 1.4-2.3 kg: 49% - 2.7-4.5 kg: 23% - 5-9.1 kg: 6% - >9.5 kg: 1%
76 <u>Wrestling</u> [11]	NR	NR	[pre-WL / WL / WG] <u>BW (kg):</u> 79.4 ± 12.6 / 75.7 ± 11.3* / 77.7 ± 11.6*# <u>Weight gain 19h after a competition weigh-in (kg):</u> +3.7 ± 1.0 (+5.2 ± 1.3%)
44 <u>Boxing</u> [25%] <u>BJJ</u> [6%] <u>Judo</u> [12%] <u>MMA</u> [11%] <u>MT/K</u> [12%] <u>TKD</u> [6%] <u>Wrestling</u> [27%] <u>total</u> [637]	BJJ / boxing / judo / MMA / MT/K / TKD / wrestling <u>Participants that have lost weight to compete (% yes):</u> 88 / 93 / 86 / 95 / 94 / 85 / 97 <u>Usual WL methods and duration:</u> see Table 1	BJJ / boxing / judo / MMA / MT/K / TKD / wrestling <u>Time between weigh-in and competition (h):</u> 6 ± 8 / 7 ± 7 / 11 ± 8 / 24 ± 11 / 18 ± 9 / 19 ± 5 / 7 ± 15 with (MMA = MT/K = TKD) > (BJJ = boxing = judo = wrestling)	BJJ / boxing / judo / MMA / MT/K / TKD / wrestling <u>Inter-season weight and usual weight variations:</u> see Table 1 <u>Usual WL within 2 weeks (kg):</u> 3.1 ± 2.3 / 3.7 ± 2.7 / 2.4 ± 2.1 / 5.6 ± 3.1 / 2.6 ± 1.7 / 3.4 ± 3.2 / 3.4 ± 3.2, with MMA > all other groups <u>Usual WL within 24 h (kg):</u> 1.4 ± 1.4 / 1.8 ± 2.1 / 1.5 ± 1.1 / 3.4 ± 1.9 / 2 ± 1.2 / 1.6 ± 1.4 / 2.3 ± 1.5, with MMA > all other groups and BJJ < wrestling <u>Usual WG between weigh-in and competition (kg):</u> 1.3 ± 1.4 / 2 ± 2.2 / 2 ± 1.3 / 5.3 ± 2.9 / 3.5 ± 3.7 / 2.2 ± 1.3 / 2.2 ± 1.4, with MMA > MT/K > wrestling > BJJ
94 <u>Jiu-jitsu,</u> <u>judo, karate,</u> <u>muay thai,</u> <u>TKD, silat</u> <u>WC</u> [43]	WC <u>Usual WL methods and duration:</u> see Table 1	NR	[pre-WL / WL / WG] WC <u>BW (kg)^{NAS}:</u> 63.4 ± 13.1 / 60.1 ± 12.6 / 62.5 ± 12.4 <u>Usual weight variations:</u> see Table 1
51 <u>Wrestling,</u> <u>judo, TKD</u> [14]	<u>Last week pre-weigh-in:</u> reduction food and fluid intake portion sizes + increased exercise	<u>Post weigh-in:</u> food and fluid intake to obtain a competitive weight and to correct the reduced glycogen stores and reversal of the hypo-hydrated state	NR

Ref sport group [n]	WL period conditions (food intake, physical activity and other methods)	WG period conditions (food intake, physical activity and other methods)	Main BW and body composition results
52 <u>Judo, TKD, wrestling</u> DIET m [7] DIET f [4]	2-3 wk pre-weigh-in (n=6): exercise and dietary regimes gradually adjusted 4-5 d pre-weigh-in: portion sizes and overall food intake reduced, often coupled with increased exercise 24 h pre-weigh-in (n=10): more extreme weight-loss methods (saunas, hot baths, exercise in sweat suits, ate or drank anything)	NR	[WL] <u>Weight variations (mean (range),% from pre-WL)^{NAS}:</u> DIET m: -5 (-1, -8)% DIET f: -5 (-5, -8)%
70 <u>Boxing, judo, TKD, wrestling</u> total [68] MWI [35] EWI [33]	NR	<u>Energy intake (kcal/d):</u> total: 2531.8 ± 1242.0 MWI: 1767.5 ± 740.4 EWI: 3343.8 ± 1194.2 <u>CHO (g/d):</u> total: 362 ± 189 MWI: 262 ± 100¶ EWI: 468 ± 204¶ <u>Lip (g/d):</u> total: 76 ± 53 MWI: 49 ± 34¶ EWI: 103 ± 56¶ <u>Prot (g/d):</u> total: 92 ± 44 MWI: 61 ± 28¶ EWI: 124 ± 33¶ <u>Fluid intake (mL/kg):</u> total: 55 ± 33 MWI: 38 ± 11¶ EWI: 73 ± 38¶ <u>Fibre (g/d):</u> total: 18 ± 10 MWI: 13 ± 7 EWI: 23 ± 10	[WL / WG] <u>BW (kg)^{NAS}:</u> total: 70.2 ± 17.6 / 72.1 ± 17.2 (+3.0 ± 2.5%) MWI: 74.3 ± 19.0 / 75.6 ± 18.8 (+1.9 ± 1.5%) EWI: 65.8 ± 14.9 / 68.4 ± 14.6 (+4.2 ± 2.8%)
100 <u>Boxing, judo, TKD, wrestling</u> [229]	Usual WL methods and duration: see Table 1	NR	Current weight and usual weight variations: see Table 1
Imposed WL conditions only			
40 <u>Boxing</u> [7]	[pre-WL / WL] Energy intake (kcal/d): 2330 ± 243 / 917 ± 134* CHO (g/d): 145 ± 5 (65 ± 13%EI) / 328 ± 40* (56 ± 3%EI) Lip (g/d): 23 ± 5 (20 ± 8%EI) / 69 ± 5* (27 ± 3%EI) Prot (g/d): 29 ± 6 (14 ± 5%EI) / 83 ± 9* (14 ± 1%EI)	NR	[pre-WL / WL / WG-1 / WG-2 / WG-3] <u>BW and weight variations from pre-WL (kg):</u> 70.9 ± 6.5 / 66.5 ± 6.0* (-6.1 ± 0.6%*) / NR (-4.2%*) / NR (-1.9%*) / NR (-1.3%*) FM (%BW): 14.5 ± 5.8 / 13.2 ± 6.8* / NR / NR / NR FM (kg): 10.5 ± 4.8 / 9.0 ± 5.2* / NR / NR / NR FFM (kg): 60.4 ± 4.6 / 57.5 ± 4.2* / NR / NR / NR TBW (%pre-WL): N/A / -5.2 ± 2.1% / NR / NR / NR
53 <u>Boxing, judo</u> [10]	[pre-WL / WL] Energy intake (kcal/d): 2458 ± 578 / 1008 ± 354* CHO (g/d): 334 ± 88 (55 ± 5%EI) / 148 ± 57* (58 ± 15%EI) Lip (g/d): 79 ± 24 (29 ± 5%EI) / 28 ± 13* (23 ± 9%EI) Prot (g/d): 86 ± 22 (14 ± 1%EI) / 31 ± 10* (12 ± 3%EI) PAL: 1.88 ± 0.13 / 1.93 ± 0.14	<u>Energy intake (kcal/d):</u> 3066 ± 506*# <u>CHO (g/d):</u> 396 ± 81*# (53 ± 8%EI) <u>Lip (g/d):</u> 113 ± 24*# (32 ± 6%EI#) <u>Prot (g/d):</u> 101 ± 19# (13 ± 2%EI) PAL: 1.40 ± 0.17#	[pre-WL / WL / WG] BW (kg): 74.4 ± 9.0 / 70.0 ± 8.8* / 73.1 ± 8.6*# FM (%BW): 17.0 ± 7.4 / 15.8 ± 7.6* / 15.9 ± 8.2* FM (kg): 13.1 ± 7.3 / 11.7 ± 7.5* / 12.1 ± 7.3*# FFM (kg): 61.2 ± 4.2 / 58.3 ± 3.8* / 61.1 ± 3.7# TBW (kg): 43.8 ± 3.1 / 41.5 ± 2.9* / 43.6 ± 2.6#

Ref sport group [n]	WL period conditions (food intake, physical activity and other methods)	WG period conditions (food intake, physical activity and other methods)	Main BW and body composition results
Imposed WG conditions only			
43 Judo DIET [10] CT [10]	[pre-WL / WL] <u>Energy intake (kcal/d):</u> DIET: 2629 ± 239 / 1673 ± 239 (-33%) <u>CHO, Lip, Prot (g/d):</u> DIET: pre-WL > WL* <u>CHO (g/d):</u> DIET: NR / 187.8 ± 60.5 CT: NR / 334.3 ± 75.9 <u>Fluid intake (mL/d):</u> DIET: 3873.2 ± 692.5 / 3102 ± 448.3	imposed	[pre-WL / WL / WG] <u>BW (kg):</u> DIET: 75.9 ± 3.1 / 72.1 ± 1.4* / 74.5 ± 3.4# CT: 73.3 ± 6.3 / 74.7 ± 6.7 / 75.1 ± 1.6 <u>BMI (kg/m²):</u> DIET: 24.9 ± 0.8 / 24.1 ± 0.7 / 24.2 ± 0.9 CT: 23.0 ± 1.3 / 23.6 ± 1.5 / 23.9 ± 1.1 <u>FM (%BW):</u> DIET: 15.8 ± 1.1 / 15.0 ± 1* / NR CT: 15.5 ± 3.3 / 14.9 ± 3 / NR <u>FFM (kg):</u> DIET: 64.5 ± 1.1 / 62.2 ± 0.6* / NR CT: 61.7 ± 5.3 / 62.5 ± 5.3 / NR
Imposed WL and WG conditions			
50 Wrestling [8]	[pre-WL (/d) / WL (/53h)] <u>Food intake (g)^{NAS}</u> : 3686 ± 1615 / 3234 ± 1591 <u>Energy intake (kcal)^{NAS}</u> : 3528 ± 829 / 2366 ± 1184 <u>CHO (g)^{NAS}</u> : 509 ± 149 (56.9 ± 5.5%EI) / 340 ± 170 (57.0 ± 11.4%EI) <u>Lip (g)^{NAS}</u> : 110 ± 24 (28.9 ± 5.3%EI) / 34 ± 20 (28.4 ± 9.3%EI) <u>Prot (g)^{NAS}</u> : 125 ± 30 (14.2 ± 0.9%EI) / 85 ± 41 (14.6 ± 2.8%EI)	<u>Food intake (g/13h)^{NAS}</u> : 669 ± 1051 <u>Energy intake (kcal/13h)^{NAS}</u> : 2891 ± 295 <u>CHO (g/13h)^{NAS}</u> : 524 ± 45 (72.7 ± 1.3%EI) <u>Lip (g/13h)^{NAS}</u> : 60 ± 9 (18.5 ± 1.1%EI) <u>Prot (g/13h)^{NAS}</u> : 64 ± 8 (8.8 ± 0.2%EI)	[pre-WL / WL / WG] <u>BW (kg)</u> : 73.7 ± 8.0 / 69.0 ± 7.7* (-6.4 ± 0.5% from pre-WL) / 71.8 ± 7.7*# (+2.5 ± 0.7% from pre-WL) <u>FM (kg)</u> : 9.0 ± 2.1 / 8.4 ± 1.9 / 7.7 ± 1.8* <u>FFM (kg)</u> : 64.3# / 60.5 ± 6.6 / 63.7 ± 6.7# <u>TBW (kg)</u> : 46.8 ± 5.6 / 43.5 ± 5.2* / 46.6 ± 5.3*#
41 Wrestling [10]	[pre-WL / WL] <u>Food intake (g/d)^{NAS}</u> : 3673 ± 1512 / 1501 ± 654 <u>Energy intake (kcal/d)^{NAS}</u> : 3426 ± 774 / 1123 ± 492 (-67.6 ± 11.2%EI) <u>CHO (g/d)^{NAS}</u> : 491 ± 138 (56.5 ± 4.9%EI) / 156 ± 68 (55.6 ± 10.6%EI) <u>Lip (g/d)^{NAS}</u> : 108 ± 22 (29.2 ± 4.7%EI) / 37 ± 20 (29.3 ± 8.5%EI) <u>Prot (g/d)^{NAS}</u> : 122 ± 28 (14.3 ± 0.8%EI) / 42 ± 20 (15.1 ± 2.9%EI) <u>Sodium (mg/d)^{NAS}</u> : 5181 ± 1307 / 1928 ± 632	imposed: ad libitum meals [WG-1 / WG-2 / WG-3 / total WG period] <u>Food intake (g/d)^{NAS}</u> : 2414 ± 431 / 1353 ± 334 / 917 ± 379 / 4685 ± 514 <u>Energy intake (kcal/d)^{NAS}</u> : 1633 ± 210 / 1014 ± 164 / 231 ± 83 / 2879 ± 310 <u>CHO (g/d)^{NAS}</u> : 290 ± 46 (70.8 ± 2.4%EI) / 199 ± 23 (79.2 ± 7.3%EI) / 33 ± 20 (54.5 ± 7.6%EI) / 522 ± 47 (72.6 ± 1.4%EI) <u>Lip (g/d)^{NAS}</u> : 36 ± 1 (20.0 ± 2.3%EI) / 14 ± 9 (11.7 ± 6.7%EI) / 10 ± 0 (39.8 ± 7.5%EI) / 60 ± 10 (18.5 ± 1.1%EI) <u>Prot (g/d)^{NAS}</u> : 37 ± 5 (9.2 ± 0.4%EI) / 23 ± 5 (9.1 ± 1.1%EI) / 3 ± 1 (5.6 ± 0.1%EI) / 64 ± 9 (8.8 ± 0.3%EI) <u>Sodium (mg)^{NAS}</u> : 2826 ± 216 / 1192 ± 429 / 58 ± 9 / 4076 ± 589	[pre-WL / WL / WG-1 / WG-2 / WG-3] <u>BW (kg)</u> : 72.5 ± 8.1 / 68.1 ± 7.7* / 70.3 ± 7.8*# / 71.2 ± 8.2*# / 70.9 ± 7.8*# <u>BW evolution (kg)</u> : - Δ WL - pre-WL: -4.6 ± 0.6* (-6.4 ± 0.7%) - Δ WG-1 - WL: +2.2 ± 0.5 - Δ WG-2 - WG-1: +3.3 ± 0.5 - Δ WG-3 - WG-2: -1.7 ± 0.6 (-2.3 ± 0.8%) <u>FM (%BW)</u> : 11.2 ± 2.0 / NR / NR / NR / NR <u>FM (kg)</u> : 8.4 ± 2.0 / 8.0 ± 1.8* / NR / NR / 8.0 ± 1.9* <u>FFM (kg)</u> : 63.2 ± 7.0 / 59.0 ± 6.7* / NR / NR / 62.0 ± 6.6*#

Ref sport group [n]	WL period conditions (food intake, physical activity and other methods)	WG period conditions (food intake, physical activity and other methods)	Main BW and body composition results
95 <u>Wrestling</u> [5, placebo and creatine groups are the same sample]	<u>Energy intake (kcal/d):</u> gradual restriction placebo: 1663 ± 732 (1 st d) to 126 ± 168 (3 rd d) creatine: 1388 ± 896 (1 st d) to 286 ± 147 (3 rd d) <u>CHO (%EI):</u> 53.4-57.1 <u>Lip (%EI):</u> 28.4-34.4 <u>Prot (%EI):</u> 11.6-14.5 <u>Physical activity:</u> maintenance close to normal training load <u>Hydration status:</u> mild sauna procedure	<u>Supplementation (g/d):</u> placebo: 320g glucose creatine: 320g glucose + 30g creatine <u>Food intake (food + supplementation):</u> - <u>Energy intake (kcal/d):</u> placebo: 3887 ± 439 creatine: 3939 ± 727 - <u>CHO (%EI):</u> placebo: 73.0 ± 3.8 creatine: 73.7 ± 5.9 - <u>Lip (%EI):</u> placebo: 18.2 ± 2.9 creatine: 17.8 ± 6.0 - <u>Prot (%EI):</u> placebo: 8.8 ± 1.2 creatine: 8.6 ± 1.7	[pre-WL / WL / WG] <u>BW (kg):</u> placebo: 74.3 ± 8.7 / 70.3 ± 7.9* / 72.7 ± 8.3*# creatine: 73.5 ± 7.6 / 70.2 ± 7.9* / 72.5 ± 8.2#
71 <u>Wrestling</u> HC [6] MC [6]	imposed	<u>Energy intake (kcal/d):</u> HC: 3205 ± 1082.7 MC: 2187 ± 710.4 <u>CHO (%EI):</u> HC: 60.7 ± 14.7 MC: 60.2 ± 6.1 <u>Lip (%EI):</u> HC: 26.3 ± 10.8 MC: 24 ± 7.6 <u>Prot (%EI):</u> HC: 13.5 ± 5.6 MC: 12.7 ± 4.4	[pre-WL / WL / WG] <u>BW and weight variations from previous time point (kg)^{NAS}:</u> total: NR / -2.4 ± 2.4 / NR HC: 72.7 ± 14.2 / NR / +1.00 ± 0.17 MC: 70.0 ± 8.08 / NR / +0.83 ± 0.51 <u>FM (%BW):</u> HC: 11.5 ± 2.4 / NR / NR MC: 11.7 ± 2.2 / NR / NR
103 <u>Judo</u> <u>wrestling</u> [10, gradual and rapid WL are the same sample]	[gradual WL: pre-WL-1 / WL-1; rapid WL: WL-2] <u>Energy intake (kcal/d):</u> gradual WL: 2550 ± 1199 / 1697 ± 1199* rapid WL: 1350 ± 1025* <u>CHO (g/d):</u> gradual WL: 302 ± 152 (48%EI) / 239 ± 177 (57%EI) rapid WL: 182 ± 174 (55%EI) <u>Lip (%EI):</u> gradual WL: 35 / 25 rapid WL: 28 <u>Prot (g/d):</u> gradual WL: 107 ± 54 (17%EI) / 71 ± 51 (18%EI) rapid WL: 56 ± 54 (17%EI) <u>PAL:</u> pre-WL-1 < WL-2; WL-1 = WG-1; WL-1 = WL-2	rapid WL [WG-2] <u>Energy intake (kcal/5h)^{NAS}:</u> 2020 ± 696 <u>CHO (g/5h)^{NAS}:</u> 285 ± 85	<u>Weight variations (kg)^{NAS}:</u> gradual WL: - Δ WL-1 - pre-WL-1: -3.7 ± 0.9 (-5.0 ± 1.3%) rapid WL: - Δ WL-2 - pre-WL-2: -4.4 ± 1.6 (-6.0 ± 1.9%) - Δ WG-2 - WL-2: +73% of relative WL-2 - Δ WL-3 - WG-2: -2.0 ± 1.3 (-2.7 ± 1.6%)

Strength and conditioning sports

Usual athletes' methods of WL and WG [not imposed by the study design]

Ref sport group [n]	WL period conditions (food intake, physical activity and other methods)	WG period conditions (food intake, physical activity and other methods)	Main BW and body composition results
15 Body building [45]	Usual WL methods and duration: see Table 1 <u>Other WL methods (% of sample):</u> - calorie counting: 56% - special diets: 18%	<u>WG methods (% of sample):</u> - amino acids: 50% - extra meals: 40% - protein powder: 32% - liquid supplements: 26% - less exercise: 11% - special diets: 11% - weight gain pills: 5%	<u>Usual weight variations: see Table 1</u> <u>Most WG this season (kg):</u> 5.9 ± 4.5
16 Body building [1]	[pre-WL / WL-1 / WL-2 / WL-3] <u>Energy intake (kcal/d)^{NAS}:</u> 2010 / 1798 / 1541 / 1712 <u>CHO (g/d)^{NAS}:</u> 225 (45%EI) / 187 (42%EI) / 143 (37%EI) / 188 (44%EI) <u>Lip (g/d)^{NAS}:</u> 70 (31%EI) / 50 (25%EI) / 41 (24%EI) / 40 (21%EI) <u>Prot (g/d)^{NAS}:</u> 120 (24%EI) / 150 (33%EI) / 150 (39%EI) / 150 (35%EI) <u>Fibre (g/d)^{NAS}:</u> 48 / 40 / 24 / 34 <u>Physical activity^{NAS}:</u> high-volume resistance training program (4–5 d/wk) + brief HIIT (1–2 d/wk) + longer aerobic exercise session (1 d/wk)	[WG-1 / WG-2] <u>Energy intake (kcal/d)^{NAS,NAS}:</u> 2032 / 2023 <u>CHO (g/d)^{NAS}:</u> 219 (43%EI) / 233 (46%EI) <u>Lip (g/d)^{NAS}:</u> 146 (29%EI) / 133 (26%EI) <u>Prot (g/d)^{NAS}:</u> 63 (28%EI) / 62 (28%EI) <u>Fibre (g/d)^{NAS}:</u> 49 / 47 <u>Physical activity^{NAS}:</u> high-volume resistance training program (3–4 d/wk) + brief HIIT (1–2 d/wk) + longer aerobic exercise session (1 d/wk)	[pre-WL / WL-1 / WL-2 / WL-3 / WG-1 / WG-2 / WG-3 / WG-4] <u>BW (kg)^{NAS}:</u> NR / 54.9 / 51.3 / 49.8 / 51.8 / 55.1 / 57.3 / 56.1 <u>FM (%BW)^{NAS}:</u> 15.1 / NR / NR / 8.6 / NR / 14.8 / 20 / 20 <u>FM (kg)^{NAS}:</u> 8.3 / NR / NR / 4.3 / NR / NR / NR / NR <u>FFM (kg)^{NAS}:</u> 44.3 / NR / NR / 44.3 / NR / NR / NR / NR <u>FFM (%BW)^{NAS}:</u> 80.7 / NR / NR / 89.0 / NR / NR / NR / NR
80 Body building [1]	<u>Energy intake^{NAS}:</u> gradually decreased - pre-WL: 3860 kcal/d (28%EI prot + 52%EI CHO + 20%EI lip) - WL-1 to WL-7: 1724 kcal (52%EI prot + 19%EI CHO + 29%EI lip) x 6 d/wk + 2130 kcal (41%EI prot + 28%EI CHO + 21%EI lip) x 1 d/wk <u>Physical activity^{NAS}:</u> resistance training 5-6 d/wk + gradually increased of aerobic training (MISS + HIIT)	<u>Energy intake^{NAS}:</u> gradually increased (reverse dieting strategy) <u>Physical activity^{NAS}:</u> aerobic exercise gradually decreased	[pre-WL / WL-1 / WL-2 / WL-3 / WL-4 / WL-5 / WL-6 / WL-7 / WG-1 / WG-2 / WG-3 / WG-4 / WG-5] <u>BW (kg)^{NAS}:</u> 85.2 / 84.1 / 84.3 / 80.8 / 80.6 / 80.1 / 79.1 / 76.1 / 76.5 / 80.5 / 82.5 / 85.2 / 86.6 <u>FM (%BW)^{NAS}:</u> - DXA: 13.8 / NR / NR / NR / NR / NR / NR / NR / 5.1 / NR / NR / NR / NR / 13.8 - BodPod: 13.4 / 12.8 / 13.5 / 11.5 / 10.3 / 11.1 / 10.3 / 9.6 / 8.9 / 11.0 / 13.0 / 15.2 / 17.2
81 Body building [1]	<u>Energy intake^{NAS}:</u> gradually decreased - pre-WL: 36%EI CHO + 28%EI lip + 36%EI prot x 5 d/wk and 48%EI CHO + 22%EI lip + 30%EI prot x 2 d/wk - WL period: progressive reduction of 5-10 g/wk in CHO and/or lip - WL-5: 29%EI CHO + 25%EI lip + 46%EI prot <u>Physical activity^{NAS}:</u> 4 d/wk resistance training (5 h/wk) + 1 d/wk HIIT (40 min/wk) + 1 d/wk low-intensity, steady-state, aerobic exercise (30 min/wk) + "posing practice" (from 1 d/wk to 4 d/wk)	<u>Energy intake^{NAS}:</u> 35-40%EI CHO + 30-35%EI lip + 25-30%EI prot <u>Physical activity^{NAS}:</u> 4 d/wk resistance training (5 h/wk) + 1 d/wk HIIT (20 min/wk)	[pre-WL / WL-1 / WL-2 / WL-3 / WL-4 / WL-5 / WL-6 / WG-1 / WG-2 / WG-3 / WG-4 / WG-5 / WG-6] <u>BW (kg)^{NAS}:</u> 102.85 / 99.36 / 96.46 / 92.27 / 90.76 / 90.23 / 88.87 / 91.06 / 94.56 / 98.03 / 98.10 / 99.55 / 98.99 <u>FM (%BW)^{NAS}:</u> - 4-C model: 14.8 / 13.4 / 12.1 / 8.9 / 6.4 / 6.6 / 4.5 / 8.4 / 8.8 / 12.6 / 15.5 / 15.0 / 14.6 - skinfolds: 8.9 / 8.2 / 6.1 / 4.6 / 5.0 / 3.5 / 3.1 / 7.0 / 7.2 / 6.7 / 6.7 / 8.2 / 6.3 <u>FFM (kg)^{NAS}:</u> 87.65 / 86.01 / 84.82 / 84.09 / 84.97 / 84.25 / 84.84 / 83.42 / 86.29 / 85.68 / 82.88 / 84.66 / 84.59 <u>TBW (kg)^{NAS}:</u> 62.60 / 61.79 / 61.19 / 60.25 / 61.99 / 60.48 / 62.12 / 60.84 / 63.71 / 63.30 / 58.89 / 60.83 / 60.31
82 Body building [1]	<u>Physical activity:</u> 4-6 d/wk resistance training + 3 - 6 d/wk aerobic training (cycling, walking/running, stepping exercise, HIIT)	NR	[pre-WL / WL-1 / WL-2 / WL-3 / WL-4 / WL-5 / WG-1 / WL-6 / WL-7 / WG-2 / WG-3 / WG-4] <u>BW (kg)^{NAS}:</u> 65.0 / 64.2 / 62.8 / 62.6 / 60.9 / 60.2 / 61.3 / 59.8 / 59.0 / 61.1 / 63.3 / 65.8 <u>FM (%BW)^{NAS}:</u> 20.3 / 19.3 / 18.0 / 15.0 / 12.7 / 12.2 / 12.2 / 11.4 / 11.6 / 11.2 / 14.7 / 18.8 <u>FM (kg)^{NAS}:</u> 13.2 / 12.4 / 11.3 / 9.4 / 7.7 / 7.3 / 7.5 / 6.8 / 6.9 / 6.8 / 9.3 / 12.3 <u>FFM (kg)^{NAS}:</u> 51.8 / 51.8 / 51.5 / 53.2 / 53.1 / 52.9 / 53.8 / 53.0 / 52.1 / 54.2 / 54.0 / 53.4 <u>TBW (kg)^{NAS}:</u> 37.5 / 37.2 / 36.5 / 37.7 / 37.1 / 37.7 / 38.3 / 37.3 / 37.1 / 38.2 / 38.2 / 38.0

Ref sport group [n]	WL period conditions (food intake, physical activity and other methods)	WG period conditions (food intake, physical activity and other methods)	Main BW and body composition results
39 Fitness DIET [27] CT [23]	[pre-WL / WL / average WL period] <u>Energy intake (kcal/d):</u> DIET: 2367.0 ± 426.6 / 1885.2 ± 344.2* / 1798.3 ± 371.9* CT: 2496.7 ± 551.5 / NR / NR <u>CHO (g/d):</u> DIET: 215.6 ± 67.7 / 126.1 ± 49.1* / 127.8 ± 39.7* CT: 218.8 ± 50.3 / NR / NR <u>Lip (g/d):</u> DIET: 64.4 ± 16.2 / 56.8 ± 16.4* / 52.8 ± 16.4* CT: 82.2 ± 23.3 / NR / NR <u>Prot (g/d):</u> DIET: 202.5 ± 44.1 / 189.7 ± 39.5* / 184.7 ± 40.5* CT: 172.3 ± 37.6 / NR / NR <u>Physical activity (METH/wk (time/wk)):</u> - Resistance training: DIET: 44.9 ± 8.6 (4.7 ± 0.7) / 46.0 ± 8.5 (4.7 ± 0.6) / NR CT: 31.9 ± 19.5 (3.9 ± 1.9) / NR / NR - Aerobic exercise: DIET: 13.3 ± 10.4 (3.6 ± 2.8) / 19.1 ± 15.6 (4.4 ± 2.9) / NR CT: 17.9 ± 23.7 (2.6 ± 2.6) / NR / NR	[Competition wk / WG] <u>Energy intake (kcal/d):</u> DIET: 2339.6 ± 610.2 / 2216.4 ± 522.6 CT: 2341.1 ± 424.0 / 2491.8 ± 370.4 <u>CHO (g/d):</u> DIET: 229.9 ± 199.0 / 188.5 ± 72.5 CT: 216.7 ± 41.4 / 224.0 ± 49.8 <u>Lip (g/d):</u> DIET: 63.9 ± 25.3 / 59.7 ± 13.0 CT: 73.8 ± 28.8 / 84.9 ± 29.4 <u>Prot (g/d):</u> DIET: 160.6 ± 32.5* / 195.4 ± 41.5 CT: 181.9 ± 37.9 / 184.7 ± 39.5 <u>Physical activity (METH/wk (time/wk)):</u> - Resistance training: DIET: 19.5 ± 10.9* (4.2 ± 1.1) / 42.4 ± 8.3 (4.6 ± 0.8) CT: NR / 32.2 ± 17.2 (3.8 ± 1.7) - Aerobic exercise: DIET: 13.2 ± 8.4 (4.4 ± 2.5) / 9.7 ± 7.8¶ (2.3 ± 1.9¶) CT: NR / 18.3 ± 24.8¶ (3.3 ± 3.5¶)	[pre-WL / WL / WG / ΔWL-pre-WL / ΔWG-WL / ΔWG-pre-WL] <u>BW and weight variations (kg):</u> DIET: 64.3 ± 6.9 / 56.5 ± 5.3 / 62.6 ± 6.9 / -11.9 ± 3.8%* / +10.9 ± 5.3%# / -2.4 ± 5.6%* CT: 64.3 ± 5.3 / 64.5 ± 5.5 / 64.4 ± 5.5 / 0.3 ± 3.1%# / -0.1 ± 3.4%# / 0.1 ± 3.7% <u>FM (kg):</u> - DXA: DIET: 14.6 ± 4.6 / 7.1 ± 2.7 / 12.7 ± 4.2 / -50.4 ± 12.4%*¶ / +84.7 ± 50.7%#¶ / -10.1 ± 25.6%* CT: 14.9 ± 3.7 / 15.5 ± 3.9 / 15.1 ± 4.4 / 5.1 ± 12.9%¶ / -2.6 ± 13.2%¶ / 2.1 ± 16.8% - bioimpedance: DIET: 12.8 ± 3.4 / 6.6 ± 2.5 / 11.2 ± 3.3 / -47.4 ± 17.9%*¶ / +91.5 ± 74.0%#¶ / -6.1 ± 29.3% CT: 13.0 ± 3.1 / 13.2 ± 3.5 / 13.0 ± 4.0 / 2.1 ± 16.2%¶ / -1.5 ± 15.6%¶ / -0.1 ± 17.8% - skinfolds: DIET: 16.3 ± 3.3 / 10.4 ± 2.2 / 16.4 ± 4.0 / -35.2 ± 11.2%*¶ / +57.9 ± 26.7%# / 1.3 ± 18.8% CT: 15.5 ± 9.4 / 16.2 ± 9.7 / 16.3 ± 9.9 / 9.5 ± 29.6%¶ / -4.5 ± 43.6% / 9.5 ± 52.4% <u>FFM (kg):</u> - DXA: DIET: 47.6 ± 4.1 / 48.0 ± 3.9 / 48.3 ± 4.3 / +1.1 ± 3.1% / +0.6 ± 3.8% / +1.7 ± 4.4% CT: 47.3 ± 4.7 / 47.2 ± 4.7 / 47.4 ± 5.0 / -0.2 ± 2.4% / 0.5 ± 2.7% / 0.3 ± 3.1% - bioimpedance: DIET: 48.6 ± 4.9 / 47.1 ± 4.3 / 47.9 ± 5.0 / -3.0 ± 4.4%* / +2.1 ± 3.2%* / -1.1 ± 4.7% CT: 49.2 ± 4.9 / 48.4 ± 4.8 / 48.5 ± 4.6 / -1.6 ± 5.8% / 0.2 ± 2.9% / -1.3 ± 6.1% - skinfolds: DIET: 48.0 ± 4.3 / 46.1 ± 3.9 / 46.3 ± 4.1 / -3.9 ± 2.7%*¶ / +0.4 ± 2.4% / -3.5 ± 3.1%* CT: 48.8 ± 6.8 / 48.2 ± 7.0 / 48.0 ± 7.1 / -1.2 ± 3.1%¶ / -0.4 ± 4.0% / -1.6 ± 4.5%
54 Fitness DIET [25] CT [17]	[pre-WL / WL] <u>Energy intake (kcal/d)^{NASG}:</u> DIET: 2348 ± 418 / 1664 ± 305* (-18%) CT: 39.6 ± 8.04 / 36.76 ± 5.77 <u>Physical activity (METH/wk)^{NASG}:</u> - Resistance training: DIET: 45.31 ± 8.76 / 46.1 ± 9.9 CT: 33.61 ± 19.44 / 28.59 ± 14.22 - Aerobic exercise: DIET: 13.95 ± 10.43 / 22.3 ± 17.79* CT: 15.76 ± 23.81 / 13.16 ± 14.54 - Total amount exercise: DIET: WL = pre-WL + 15%* CT: pre-WL = WL <u>Energy availability (kcal/kg of FFM/d)^{NASG}:</u> DIET: WL = pre-WL - 29%* CT: pre-WL = WL	<u>Energy intake (kcal/d)^{NASG}:</u> DIET: 2315 ± 549 CT: 2518 ± 380 <u>Physical activity (METH/wk)^{NASG}:</u> - Resistance training: DIET: 42.25 ± 8.23 CT: 32.11 ± 17.77 - Aerobic exercise: DIET: 10.99 ± 12.19 CT: 16.65 ± 25.61 <u>Energy availability (kcal/kg FFM/d)^{NASG}:</u> DIET: pre-WL > WG* CT: pre-WL = WG	[pre-WL / WL / WG] <u>BW (kg)^{NASG}:</u> DIET: 64.72 ± 6.92 / 56.62 ± 5.51* / 63.17 ± 6.92* CT: 63.71 ± 5.07 / 64.02 ± 5.76 / 63.64 ± 5.55 <u>BMI (kg/m²)^{NASG}:</u> DIET: 23.54 ± 1.82 / 20.6 ± 1.42* / 22.99 ± 2.03* CT: 23.08 ± 1.36 / 23.2 ± 1.78 / 23.05 ± 1.57 <u>FM (kg)^{NASG}:</u> DIET: 14.88 ± 4.47 / 7.17 ± 2.69* / 12.99 ± 4.21* CT: 14.19 ± 3.05 / 14.87 ± 3.48 / 14.39 ± 3.17 <u>FFM (kg)^{NASG}:</u> DIET: 47.69 ± 4.2 / 48.12 ± 4.03 / 48.5 ± 4.43* CT: 47.52 ± 3.83 / 47.44 ± 3.8 / 47.53 ± 4.05

Ref sport group [n]	WL period conditions (food intake, physical activity and other methods)	WG period conditions (food intake, physical activity and other methods)	Main BW and body composition results
55 Fitness DIET [25] CT [17] FINRISK [58]	[pre-WL / WL] <u>Energy intake (kcal/kg/d):</u> DIET: 36.51 ± 6.54 μ / 29.62 ± 5.49* CT: 39.60 ± 8.04 μ / 36.76 ± 5.77 FINRISK: 32.90 ± 10.20 μ / N/A <u>CHO (g/kg/d):</u> DIET: 3.35 ± 1.02 μ / 2.06 ± 0.64* CT: 3.58 ± 0.57 μ / 3.42 ± 0.60 FINRISK: 3.99 ± 1.42 μ / N/A <u>Lip (g/kg/d):</u> DIET: 0.98 ± 0.25 / 0.84 ± 0.22* CT: 1.28 ± 0.39 / 1.17 ± 0.44* FINRISK: 1.10 ± 0.35 / N/A <u>Prot (g/kg/d):</u> DIET: 3.14 ± 0.63 μ / 3.06 ± 0.66 CT: 2.77 ± 0.47 μ / 2.80 ± 0.50 FINRISK: 1.43 ± 0.50 μ / N/A <u>Physical activity (METH/wk):</u> - Total exercise level: DIET: 59.30 ± 13.80 / 68.40 ± 19.60* CT: 49.40 ± 27.80 / 41.80 ± 18.70 FINRISK: 31.30 ± 19.70* / N/A - Resistance training: DIET: 45.31 ± 8.76 / 46.1 ± 9.9 CT: 33.61 ± 19.44 / 28.59 ± 14.22 FINRISK: NR / N/A - Aerobic exercise: DIET: 13.95 ± 10.43 / 22.3 ± 17.79* CT: 15.76 ± 23.81 / 13.16 ± 14.54 FINRISK: NR / N/A NASG between DIET and CT	<u>Energy intake (kcal/kg/d):</u> DIET: 37.80 ± 9.87 CT: 39.74 ± 5.46 FINRISK: N/A <u>CHO (g/kg/d):</u> DIET: 3.24 ± 1.34 CT: 3.59 ± 0.79 FINRISK: N/A <u>Lip (g/kg/d):</u> DIET: 1.02 ± 0.23 CT: 1.38 ± 0.46 FINRISK: N/A <u>Prot (g/kg/d):</u> DIET: 3.34 ± 0.81 CT: 2.86 ± 0.53 FINRISK: N/A <u>Physical activity (METH/wk):</u> - Total exercise level: DIET: 53.20 ± 16.20 CT: 48.80 ± 27.00 FINRISK: N/A - Resistance training: DIET: 42.25 ± 8.23 CT: 32.11 ± 17.77 FINRISK: N/A - Aerobic exercise: DIET: 10.99 ± 12.19 CT: 16.65 ± 25.61 FINRISK: N/A NASG between DIET and CT	[pre-WL / WL / WG] <u>BW (kg):</u> DIET: 64.72 ± 6.92 / 56.62 ± 5.51* / 63.17 ± 6.92* CT: 63.71 ± 5.07 / 64.02 ± 5.76 / 63.64 ± 5.55 FINRISK: 62.10 ± 7.84 / N/A / N/A <u>BMI (kg/m²):</u> DIET: 23.54 ± 1.82 / 20.6 ± 1.42* / 22.99 ± 2.03* CT: 23.08 ± 1.36 / 23.2 ± 1.78 / 23.05 ± 1.57 FINRISK: 22.9 ± 2.6 / N/A / N/A <u>FM (kg):</u> DIET: 14.88 ± 4.47 μ / 7.17 ± 2.69* / 12.99 ± 4.21* CT: 14.19 ± 3.05 μ / 14.87 ± 3.48 / 14.39 ± 3.17 FINRISK: 17.80 ± 5.69 μ / N/A / N/A <u>FFM (kg):</u> DIET: 47.69 ± 4.2 μ / 48.12 ± 4.03 / 48.5 ± 4.43* CT: 47.52 ± 3.83 μ / 47.44 ± 3.8 / 47.53 ± 4.05 FINRISK: 44.30 ± 2.89 μ / N/A / N/A NASG between DIET and CT
42 Fitness DIET [25] CT [17]	[pre-WL / WL] DIET <u>Energy intake (kcal/d):</u> -19% from pre-WL (mainly from CHO) <u>Physical activity:</u> +15% from pre-WL - Aerobic training (time/wk): 3.8 ± 2.8 / 4.8 ± 3.0 - Total volume exercise: WL = pre-WL + 15%	DIET <u>Physical activity:</u> Aerobic training (time/wk): 2.3 ± 2.2	<u>BW (kg):</u> DIET: pre-WL < (WL and WG) CT: pre-WL = WL = WG <u>FM (kg):</u> DIET: pre-WL > (WL (-52% from pre-WL) and WG) CT: pre-WL = WL = WG
96 Power lifting WC [200] regular WC [268]	WC: Usual WL methods and duration: see Table 1 Other WL methods (% of sample, sum of 'always' and 'sometimes' answers): - Low fibre/low residue diet: 50.5%	NR	<u>Usual BW variations:</u> WC see Table 1 [pre-WL / WL / WG] <u>BW (kg)^{NAS}:</u> regular WC: 82.20 ± 28.27 / 79.78 ± 27.86 / 82.75 ± 28.45

Imposed WL conditions only

Ref sport group [n]	WL period conditions (food intake, physical activity and other methods)	WG period conditions (food intake, physical activity and other methods)	Main BW and body composition results
97	[pre-WL / WL]		
<u>Body building</u>	<u>Energy intake (kcal/d):</u>	<u>Energy intake (kcal/d):</u>	[pre-WL / WL-1 / WL-2 / WG-1 / WG-2]
<u>FLEX</u> [11]	FLEX: 2289 ± 741 / 1827 ± 453* (-20%EI)	FLEX: 2067 ± 433	<u>BW (kg):</u>
<u>RIGID</u> [12]	RIGID: 1904 ± 504 / 1567 ± 226* (-17.7%EI)	RIGID: 1721 ± 318#	FLEX: 76.1 ± 8.4 / 74.2 ± 8.4 / 73.5 ± 8.8\$ / 74.1 ± 9.7 / 75.2 ± 9.8\$
	<u>CHO (g/d):</u>	<u>CHO (g/d):</u>	RIGID: 74.9 ± 12.2 / 73.0 ± 11.5 / 71.9 ± 11.7\$ / 72.4 ± 10.8 / 72.3 ± 11.6
	FLEX: 235 ± 112 (41%EI) / 153 ± 44* (34%EI)	FLEX: 218 ± 64# (42%EI)	<u>FM (%BW):</u>
	RIGID: 181 ± 74 (38%EI) / 126 ± 41* (32%EI)	RIGID: 168 ± 54# (39%EI)	FLEX: 19.4 ± 8.5 / 17.9 ± 7.9 / 17.0 ± 7.1\$ / 17.2 ± 6.4 / 17.0 ± 6.6
	<u>Lip (g/d):</u>	<u>Lip (g/d):</u>	RIGID: 24.0 ± 6.2 / 21.8 ± 7.3 / 20.7 ± 7.1\$ / 21.6 ± 7.2 / 22.1 ± 6.8\$
	FLEX: 89 ± 36 (35%EI) / 67 ± 29* (33%EI)	FLEX: 67 ± 19 (29%EI)	<u>FM (kg):</u>
	RIGID: 84 ± 33 (40%EI) / 59 ± 23* (34%EI)	RIGID: 61 ± 19 (32%EI)	FLEX: 14.8 ± 5.7 / 13.1 ± 5.6 / 12.5 ± 5\$ / 12.5 ± 4.4 / 12.5 ± 4.4
	<u>Prot (g/d):</u>	<u>Prot (g/d):</u>	RIGID: 18.1 ± 6.2 / 15.9 ± 6.5 / 14.9 ± 6.5\$ / 15.6 ± 6.4 / 16.0 ± 6.4\$
	FLEX: 137 ± 39¶ (24%EI) / 153 ± 20 (33%EI)	FLEX: 148 ± 37 (29%EI)	<u>FFM (kg):</u>
	RIGID: 106 ± 29¶ (22%EI) / 133 ± 40* (34%EI)	RIGID: 125 ± 27 (29%EI)	FLEX: 61.3 ± 11.3 / 61.1 ± 10.5 / 61.0 ± 10.4 / 61.6 ± 10.8 / 62.7 ± 11.3\$
			RIGID: 56.8 ± 10.7 / 57.1 ± 11.0 / 57.0 ± 10.8 / 56.8 ± 10.3 / 56.3 ± 10.5
Combat sports + strength and conditioning sports + other sports			
101	<u>Physical activity (post-career, h/wk):</u>	NR	[18 yo / 20-25 yo / 26-30 yo (= mean age of retirement) / 31-35 yo / 36-40 yo / 41-45 yo / 46-50 yo / 51-55 yo]
<u>Boxing</u> [22]	boxing: 5.41 ± 6.43		<u>BMI (kg/m²)^{NAS}:</u>
<u>Judo</u> [16]	judo: 3.81 ± 2.14		DIET: 21.5 / 22.5 / 23.2 / 24.5 / 24.6 / 24.9 / 25.1 / NR
<u>LW rowing</u>	LW rowing: 4.86 ± 4.24		- boxing: 19.9 / 20.4 / 21.3 / 24.5 / 24.1 / 24.5 / NR / NR (+3.78 ± 2.9 between 18 yo and 2009)
[33]	wrestling: 4.86 ± 3.39		- judo: 22.4 / 23.5 / 23.7 / 24.1 / 23.9 / 23.4 / 25.4 / 24.1 (+2.05 ± 1.1 between 18 yo and 2009)
<u>Wrestling</u>			- LW rowing: 21.8 / 21.9 / 22.6 / 23.4 / 23.2 / 23.4 / 24.3 / NR (+2.30 ± 0.87 between 18 yo and 2009)
[33]			- wrestling: 22 / 24 / 25 / 25.7 / 26.2 / 26.2 / 25.5 / 26.5 (+4.87 ± 4.2 between 18 yo and 2009)
<u>DIET</u> [104]			CT: 22.6 / 23.6 / 24.0 / 24.0 / 24.2 / 25.0 / 25.1 / NR
<u>CT</u> [38]			<u>WG 18 yo vs 51-55 yo (kg):</u>
			DIET: 3.4 ± 5.6
			CT: 2.5 ± 5.8
			<u>WL per diet (%BW):</u>
			boxing: 5.07 ± 1.82¶
			judo: 4.66 ± 1.33μ
			LW rowing: 4.5 ± 2.33£
			wrestling: 7.38 ± 2.79¶μ£
			<u>cumulated WL in career (kg):</u>
			boxing: 72.27 ± 37.69¶
			judo: 59.31 ± 48.66μ
			LW rowing: 23.11 ± 18.96¶μ£
			wrestling: 67.74 ± 52.81£

Ref sport group [n]	WL period conditions (food intake, physical activity and other methods)	WG period conditions (food intake, physical activity and other methods)	Main BW and body composition results
98 <u>Boxing, jiu-jitsu, judo, karate, MMA, power lifting, TKD, weight lifting, wrestling, viet vo dao, yoseikan budo</u> [168]	Usual WL methods and duration: see Table 1	NR	[pre-WL / WL / WG] <u>BW (kg)^{NASG}</u> : 67.18 ± 12.21 / 64.40 ± 11.88 / 66.69 ± 11.99 <u>Usual weight variations: see Table 1</u>
102 <u>Boxing, weight lifting, wrestling</u> WC [273] CT [1093] NA [667]	<u>Physical activity (MET/month)</u> : CT (36.8¶) > WC (29.1¶) > NA (17.7¶)	NR	[20 yo (n=2033) / 1985 (n=1726) / 1995 (n=1074) / 2001 (n=470)] <u>BMI (mean (range), kg/m²)</u> : WC: 22.8 (22.5-23.1) / 27.8 (27.4-28.3)¶ / 28.1 (27.5-28.8)¶ / 27.4 (25.5-28.4) CT: 22.6 (22.5-22.7) / 25.7 (25.5-25.9)¶ / 25.3 (25.0-25.5)¶ / 26.4 (25.9-26.9) NA: 22.7 (22.6-22.9) / 26.5 (26.2-26.8)μ / 26.9 (26.5-27.2)μ / 27.4 (26.8-27.9) <u>Weight variations vs 20 yo (mean (range), kg)</u> : WC: N/A / 15.1 (13.9-16.3)¶ / 15.2 (13.4-17.0)¶ / 14.2 (11.4-17.0) CT: N/A / 9.6 (8.9-10.2)¶ / 8.5 (7.7-9.3)¶ / 10.4 (9.1-11.8) NA: N/A / 11.8 (11.0-12.6)* / 12.4 (11.4-13.5) / 14.8 (13.1-16.4)
77 <u>Rowing</u> m [12] f [6]	[pre-WL / WL-1 / WL-2] <u>Energy intake (kcal/d)^{NASG}</u> : m: 2628.3 ± 535.4 / 2308.1 ± 685.9 / 2341.1 ± 1170.9 f: 1640.5 ± 522.9 / 1202.9 ± 607.6* / 1188.3 ± 509.8* <u>CHO (g/d)^{NASG}</u> : m: 354 (52%EI) / 427 (65%EI) / 415 (67%EI) f: 260 (58%EI) / 208 (63%EI) / 214 (68%EI) <u>Lip (g/d)^{NASG}</u> : m: 86 (28%EI) / 37 (21%EI)* / 33 (14%EI)* f: 48 (21%EI) / 34 (22%EI) / 32 (15%EI) <u>Prot (g/d)^{NASG}</u> : m: 98 (15%EI) / 98 (19%EI) / 100 (18%EI) f: 73 (17%EI) / 48 (16%EI) / 37 (15%EI)*	<u>Energy intake (kcal/d)^{NASG}</u> : m: 3035.1 ± 1260.8 f: 2069.8 ± 875.0 <u>CHO (g/d)^{NASG}</u> : m: 354 (46%EI) f: 263 (52%EI) <u>Lip (g/d)^{NASG}</u> : m: 113 (34%EI) f: 73* (31%EI) <u>Prot (g/d)^{NASG}</u> : m: 118 (16%EI) f: 90 (18%EI)	[pre-WL / WL-1 / WL-2 / WG] <u>BW (kg)^{NASG}</u> : m: 76.0 ± 3.5 / 72.9 ± 2.8* / 69.8 ± 5.5* / 76.5 ± 4.2 f: 60.8 ± 3.4 / 58.2 ± 2.2* / 57.0 ± 2.7* / 61.2 ± 3.7 <u>FM (Withers.%BW)^{NASG}</u> : m: 10.02 ± 3.1 / 7.82 ± 2.8* / 8.31 ± 2.4* / 10.80 ± 4.8 f: 22.14 ± 1.2 / 19.68 ± 2.4* / NR / 23.40 ± 2.0 <u>FM (DXA, kg)^{NASG}</u> : m: 7.1 ± 1.4 / 5.6 ± 1.0* / 6.1 ± 0.7* / 7.9 ± 1.7 f: 12.5 ± 0.5 / 10.8 ± 0.5* / NR / 12.2 ± 0.5 <u>FFM (kg)^{NASG}</u> : m: 64.1 ± 1.4 / 63.8 ± 1.4 / 63.7 ± 1.4 / 64.8 ± 1.0 f: 43.8 ± 1.0 / 43.9 ± 1.0 / NR / 43.5 ± 0.7
Soldiers Usual soldiers WL and WG habits			

Ref sport group [n]	WL period conditions (food intake, physical activity and other methods)	WG period conditions (food intake, physical activity and other methods)	Main BW and body composition results
104 Soldiers WC [190] CT [385]	Usual WL methods and duration: see Table 1 Other WL methods (% of sample, sum of 'always' and 'sometimes' answers): - Supplement use: WC: 17.9%¶ CT: 10.6%¶ - Neck exercises/Waist trainer: WC: 12.2%¶ CT: 5.5%¶ - Dehydration: WC: 18.4%¶ CT: 7.8%¶ - Other methods: WC: 0% CT: 0.3%	NR	BMI (kg/m ²): WC: 26.9 ± 3.8¶ CT: 25.1 ± 3.3¶
Imposed WL conditions			
37 Soldiers [10]	imposed	NR	[pre-WL / WG-1 / WG-2] BW (kg): 82.49 ± 7.71 / 85.36 ± 7.54* / 85.48 ± 8.15* FM (%BW): 15.6 ± 3.9 / 17.7 ± 2.3* / 19.3 ± 3.0*\$ FM (kg): 12.3 ± 3.0 / 14.4 ± 2.0* / 15.7 ± 2.8* FFM (kg): 67.5 ± 7.6 / 67.1 ± 6.7 / 65.5 ± 7.2
Imposed WL and WG conditions			
35 Soldiers g1 [55] g2 [50] g2sub [10]	imposed	imposed	[pre-WL / WL-2 / WG-2 / WL-4 / WG-4] BW (kg): g2: 78.4 ± 8.7 / 72.9 ± 7.7* / 75.3 ± 7.5*# / NR / NR: 73.9 ± 2.9 / 68.1 ± 2.3\$ / 73.9 ± 1.5\$ / 65.5 ± 2.3\$* / 76.3 ± 3.0\$ FM (kg): g2sub: 9.5 ± 1.5 / NR / NR / 5.3 ± 0.9 / 13.7 ± 1.2\$ (+40% above normal levels) FFM (kg): g2sub: 64.4 ± 1.6 / NR / NR / 60.2 ± 1.9 / 65.5 ± 2.2\$
36 Soldiers [10]	imposed	imposed	[pre-WL / WL / WG] BW (kg): 74.1 ± 9.1 / 65.6* (-11.3% from pre-WL) / 79.3*# (+20.8% from WL, +7.1% from pre-WL) FM (%BW): 12 ± 5 / 8 ± 4* / 17 ± 3*# FM (kg): 10 ± 5 / 5 ± 3* (-42.6% from pre-WL) / 14 ± 4*# (+190.4% from WL, +61.7% from pre-WL) FFM (kg): 65 ± 5 / 60 ± 6* (-6.6% from pre-WL) / 66 ± 7# (+8.8% from WL, +1.6% from pre-WL)

Ref sport group [n]	WL period conditions (food intake, physical activity and other methods)	WG period conditions (food intake, physical activity and other methods)	Main BW and body composition results
34 Soldiers LOW [19] HIGH [19]	[pre-WL / WL (imposed)] <u>Energy intake (kcal/d)^{NAST}:</u> LOW: 3196 ± 996 / 1183 ± 168 HIGH: 3338 ± 1313 / 1174 ± 170 <u>CHO (g/d)^{NAST}:</u> LOW: 370.4 ± 122.9 / 146.1 ± 16.1¶ HIGH: 395.8 ± 179.6 / 50.1 ± 10.6¶ <u>Lip (g/d)^{NAST}:</u> LOW: 101.4 ± 48.8 / 27.8 ± 6.9 HIGH: 123 ± 61.3 / 37.8 ± 4.4 <u>Prot (g/d)^{NAST}:</u> LOW: 159.2 ± 61.1 / 79.2 ± 11.4¶ HIGH: 144.8 ± 44.1 / 156.5 ± 22.6¶ <u>Physical activity (min)^{NAST}:</u> total: NR / 459 ± 273 <u>Daily energy deficit (kcal/d)^{NAST}:</u> LOW: NR / -4373 ± 1250 (-77.0 ± 1.8%) HIGH: NR / -4271 ± 1075 (-77.7 ± 6.8%)	ad libitum	[pre-WL / WL / WG] <u>BW (kg):</u> LOW: 76.2 ± 12.2 / 71.6 ± 11.6* / 75.3 ± 11.2# HIGH: 75.9 ± 12.2 / 71.9 ± 11.9* / 76.2 ± 11.2# <u>FM (kg):</u> LOW: 13.2 ± 7.7 / 8.6 ± 7.0* / NR HIGH: 16.0 ± 5.6 / 11.3 ± 6.5* / NR <u>FFM (kg):</u> LOW: 58.8 ± 7.8 / 59.5 ± 6.9 / NR HIGH: 58.8 ± 10.5 / 59.7 ± 9.8 / NR

= : non-significant result between measures; > : significant decrease between measures; < : significant increase between measures; * : significant difference with pre-WL; #: significant difference with the last WL time point measurement; \$: significant difference with previous time point; ¶, μ, £: significant difference between groups for a same symbol at a same time point; Δ: difference between two time points measurement; %EI: percentage of energy intake; BJJ: Brazilian jiu-jitsu; BMI: body mass index; BW: body weight; CHO: carbohydrates; CT: control group; d: day; DIET: dieters; EWl: evening weigh-in group; f: female; FFM: fat-free mass; FM: fat-mass; h: hour; HIIT/ MIIS/ LISS: high/ moderate/ low intensity interval training; IR: interquartile range; Lip: lipids; LW/ MW/ HW: lightweight/ middleweight/ heavyweight; m: male; METH: metabolic equivalent hours; MMA: mixed martial art; mo: month; MT/K: muay thai/kickboxing; MWI: morning weigh-in group; ^{NAS}: non-apparent statistical result; ^{NASG}: non-apparent statistical result between groups; ^{NAST}: non-apparent statistical results between time points; N/A: not-applicable; NR: not reported; NS: non-significant result; PAL: physical activity level; Prot: proteins; SD: standard deviation; SMR: sleeping metabolic rate; TBW: total body water; TKD: taekwondo; WC: weight-cyclers; WD: weight difference; WG: weight gain; wk: week; WL: weight loss.

Table S4. References included per meta-analysis.

		N	n	BW (kg)	N	n	FM (kg)	N	n	FM (%)	N	n	FFM (kg)
Gender	male	24	24	2,11,13,38,41,43,53,78,79,83–88,90–95	5	6	41,53,87,88,92	6	8	53,85,87,88,92,93	6	8	41,53,85,87,88,93
	female	5	6	11,39,83,89,94	1	1	39	0	0	NA	1	1	39
Diet status	DIET/WC	32	38	2,11–13,16,38,39,41,43,53,78–81,83–100	10	10	16,39,41,53,80,81,87,88,92,97	10	10	16,39,41,53,80,81,87,88,92,97	10	10	39,41,53,85,87,88,93,97
	non-DIET/WC	6	6	39,43,85–87,94	2	2	39,87	2	2	85,87	3	3	39,85,87
Sport category	combat sports	25	32	2,11–13,38,41,43,53,78,79,83–95,99,100	5	6	41,53,87,88,92	6	7	53,85,87,88,92,93	6	7	41,53,85,87,88,93
	strength and conditioning sports	6	5	16,39,80,81,96,97	5	4	16,39,80,81,97	4	3	16,80,81,97	2	3	39,97
WL duration	]0;7] days	10	10	12,38,41,43,53,85,91,93–95	2	2	41,53	3	3	53,85,93	4	4	41,53,85,93
	]7;14] days	7	12	11,13,83,84,92,98,100	1	1	92	1	1	92	0	0	NA
	]14;31] days	6	7	2,11,87–89,100	2	3	87,88	2	3	87,88	2	3	87,88
	]1;3] months	3	3	78,79,97	1	2	97	1	2	97	1	2	97
	]3;6] months	4	2	16,39,80,81	4	2	16,39,80,81	3	1	16,80,81	1	1	39
WG duration	]0;1] day	10	9	2,38,41,43,53,78,79,92,93,95	3	3	41,53,92	3	3	41,53,92	3	3	41,53,92
	]1;7] days	16	23	11–13,83–85,88,90–94,96,98–100	2	2	88,92	4	4	85,88,92,93	3	3	85,88,93
	]7;14] days	2	3	87,89	1	2	87	1	2	87	1	2	87
	]14;31] days	1	1	92	1	1	92	1	1	92	0	0	NA
	]1;3] months	1	2	97	1	2	97	1	2	97	1	2	97
	]3;7] months	5	3	16,39,80,81,86	4	2	16,39,80,81	3	1	16,80,81	1	1	39
WG > 1 day	overall	18	19	16,39,80,81,83–94,96–98	8	8	16,39,80,81,87,88,92,97	9	9	16,80,81,85,87,88,92,93,97	8	8	16,39,80,81,87,88,92,97
WL x WG duration\$	RWL x RWG	16	22	11–13,38,41,43,53,83–85,91,93–95,98,100	3	3	41,53,92	4	4	53,85,92,93	4	4	41,53,85,93
	RWL x LWG	1	1	92	1	1	92	1	1	92	0	0	NA
	LWL x RWG	9	9	2,11,78,79,87–89,96,100	2	3	87,88	2	3	87,88	2	3	87,88
	LWL x LWG	5	4	16,39,80,81,97	5	4	16,39,80,81,97	4	3	16,80,81,97	2	3	39,97

⁷⁸ and ⁷⁹ case studies were pooled as one study. ¹⁶, ⁸⁰ and ⁸¹ case studies were pooled as one study.

As no results were reported for the total dieters' group, subgroups were considered in the following articles: ⁸⁷ (LEI / VLEI), ¹¹ (Rm / Rf / INm / INF), ¹⁰⁰ (type of sports), ¹³ (junior / senior), and ⁹⁷ (FLEX / RIGID).

BW: body weight, FFM: fat-free mass, FM: fat mass, N: number of studies included per meta-analyses, n: number of groups considered per meta-analyses, WG: weight gain, WL: weight loss.

Table S5. Additional results of interest by type of sport in response to imposed or not weight loss and/or weight gain strategies (quantitative data are given as mean ± SD).

Ref sport group [n]	Anthropometry/Body composition and weight management	Biological parameters	Energy expenditure	Physical condition/performance	Eating behaviors and psychological status
Combat sports					
Usual athletes' methods of WL and WG [not imposed by the study design]					
59 <u>Boxing</u> [142]	N/A	N/A	N/A	<u>Performance (fight issue)</u> : NS correlation between WG or WD, and fight issue (losers vs winners)	N/A
84 <u>Boxing</u> [61]	<u>WL history ≥ 5kg (% of sample)</u> : 50.8 <u>RWL practice before 17 yo (% of sample)</u> : 34.4	N/A	N/A	N/A	N/A
78 <u>Boxing</u> [1]	N/A	N/A	<u>REE (kcal/d)^{NAS}</u> : - T1 (estimated): 2035 - T6 (measured): 1983 - T7 (measured): 1939 - T8 (measured): 1920 - T10 (estimated): 1971 - T11 (estimated): 1985 - mean REE value: 1972 ± 40	N/A	N/A
60 <u>Boxing</u> [399]	<u>BW</u> : 97.5% of the athletes regain BW between official weigh-in and competition	N/A	N/A	N/A	N/A
85 <u>Boxing</u> <u>DIET</u> [10] <u>non-DIET</u> [7]	N/A	N/A	<u>REE (kcal/d)</u> : DIET vs non-DIET : NS at WG	N/A	N/A
38 <u>Judo</u> <u>WC</u> [68] <u>non-WC</u> [7]	N/A	<u>Glucose (mg/dL)</u> : WC : pre-WL = WL; WL = WG; pre-WL < WG non-WC : pre-WL = WL = WG WC vs non-WC : NS	N/A	<u>Anaerobic work (absolute (W) and relative (W/kg) mean and peak power)</u> : WC and non-WC : pre-WL < WG <u>Performance (effort time, recovery time, standing combat, groundwork, number of attacks)</u> : WC and non-WC : pre-WL = WL WC vs non-WC : NS	N/A
12 <u>Judo</u> m [607] f [215] WC [688]	<u>RWLO score</u> : m (25.5) = f (27) but: - athletes who had switched to a heavier weight class (28.5) > athletes who had not changed (24.5) - regional level (17.5) < (state level (25) = national level (28) = international level (31.5)), with state level < international level	N/A	N/A	N/A	N/A
86 <u>Judo</u> WC [9] non-WC [9]		<u>Insulin (pmol/L)</u> : WC : pre-WL = WL = WG non-WC : pre-WL = WL = WG <u>Glucose (nmol/dL)</u> : WC : pre-WL = WL = WG non-WC : pre-WL = WL = WG <u>T3 (umol/L)</u> : WC : pre-WL > (WL = WG) <u>T4 (nmol/L)</u> : non-WC : pre-WL > (WL = WG)	[pre-WL / WL / WG] <u>REE (kcal/d)</u> : WC = non-WC WC : 1610.5 ± 306.0 / 1602.7 ± 408.1 / 1622.9 ± 365.2 non-WC : 1625.9 ± 204 / 1644 ± 276.1 / 17 28 ± 278.2	N/A	N/A

Ref sport group [n]	Anthropometry/Body composition and weight management	Biological parameters	Energy expenditure	Physical condition/performance	Eating behaviors and psychological status
88 Judo total [10] slight WL [5] marked WL [5]	N/A	<u>TG (mg/dL):</u> total and slight WL: pre-WL = WL-1; pre-WL > WL-2; pre-WL = WG marked WL: pre-WL = WL-1, WL-2 and WG <u>FFA (mEq/L):</u> total, slight and marked WL: pre-WL < WL-1 and WL-2; pre-WL = WG	N/A	<u>Anaerobic work (high power, middle power (W)):</u> total and slight WL: pre-WL = WL-1, WL-2 and WG marked WL: pre-WL = WL-1; pre-WL > WL- 2; pre-WL = WG <u>Muscle strength (handgrip, dorsal back, elbow (kg)):</u> total, marked WL and slight WL: pre-WL = WL-1, WL-2 and WG marked WL vs slight WL: NS <u>Vertical jump (cm):</u> total, marked WL and slight WL: pre-WL = WL-1, WL-2 and WG marked WL vs slight WL: NS	N/A
56 Judo judo [48] AS [20] m [30] f [38]	[pre-WL] <u>BMD (g/cm²):</u> judo > AS	N/A	N/A	N/A	<u>Dietary: calcium consumption (mg/d):</u> judo > AS m > f
57 Judo m [22] f [26] WC [19]	N/A	<u>Insulin for a loss or regain of 4 kg (% of pre-WL):</u> WC: pre-WL > WL-2 (-31%); WL-2 < WG (+18%) m vs f: NS	N/A	N/A	N/A
58 Judo WC [19] WC m [9] WC f [10] non-WC m [13] non-WC f [16]	N/A	N/A	N/A	<u>Muscle strength (handgrip (kg), n = 45):</u> WC and non-WC: pre-WL = WL = WG <u>Vertical jump (cm, n = 33):</u> non-WC m, WC f and non-WC f: pre-WL = WL = WG WC m: pre-WL > WL > WG	N/A
63 Judo winners [44] losers [42]	N/A	N/A	N/A	<u>Performance (fight issue):</u> significant correlation between WG and fight issue (winners %WG > losers %WG)	N/A
2 MMA winners [8] losers [7]	N/A	N/A	N/A	<u>Performance (lower limbs sequences (%), high- intensity blocks (n), upper and lower limbs combinations (n)):</u> significant positive correlation with WG (winners %WG > losers %WG)	N/A
64 MMA [40]	<u>Hydration (USG):</u> WL < WG - WG: 39% of subjects were dehydrated at WG - NS correlation between BW changes and hydration	N/A	N/A	N/A	N/A

Ref sport group [n]	Anthropometry/Body composition and weight management	Biological parameters	Energy expenditure	Physical condition/performance	Eating behaviors and psychological status
79 <u>MMA</u> [1]	N/A	<u>TG (mmol/L)</u> : ↓ from WL-1 to WL-3; ↑ from WL-3 to WL-6; ↓ from WL-6 to WL-7; ↑ from WL-7 to WL-8; WL-8 = WG-2 <u>HDL-C, LDL-C, total-C (mmol/L)</u> : ↑↑ from WL-1 to WL-8; ↓ from WL-8 to WG-2	[pre-WL / WL-1 / WL-2 / WG-2] <u>REE (kcal/d)</u> : 1906 / 1873 / 1575 / 1978\$	<u>Maximal oxygen uptake (peak (mL/kg/min))</u> : ↑ from pre-WL to WL; ↓ from WL-1 to WL-2	N/A
91 <u>MMA</u> [7]	<u>Hydration (UOSM (mOsmol/kg))</u> : - pre-WL < WL; WL > WG - at WL: 57% dehydrated + 43% severely dehydrated - at WG: 57% hyperhydrated + 29% euhydrated + 14% dehydrated	N/A	N/A	N/A	N/A
65 <u>Wrestling</u> [8]	<u>Hydration (USG)</u> : WL > (WG-1 = WG-3) > WG-2 - WL: 88% of the sample was severely dehydrated - WG-1: 38% still severely dehydrated - off-season: 50% of the sample was moderately dehydrated	N/A	N/A	N/A	N/A
66 <u>Wrestling winners</u> [266] <u>losers</u> [269]	N/A	N/A	N/A	<u>Performance (fight issue)</u> : NS correlation between WG and fight issue (winners %WG = losers %WG)	N/A
67 <u>Wrestling</u> [13]	<u>Hydration (USG; UOSM (mOsmol/kg))</u> : significant dehydration at WL-4	N/A	N/A		N/A
74 <u>Wrestling WC</u> [8] <u>non-WC</u> [6]	<u>Total skinfold (mm)</u> : <u>WC and non-WC</u> : pre-WL = WL-1 and WG; WL-1 < WG	N/A	<u>REE (kcal/kg FFM)</u> : <u>WC and non-WC</u> : pre-WL = WL period = WG <u>WC vs non-WC</u> : NS	N/A	N/A
68 <u>Wrestling DIET</u> [27] <u>non-DIET</u> [24]	<u>Hydration (USG; USOM)</u> : <u>DIET vs non-DIET</u> : DIET < non-DIET at WL - 27 % of total subjects were severely dehydrated at WL (44% DIET + 8% non-DIET) - hypohydration at WL: DIET = 5 x non-DIET - significant positive correlation between dehydration and amount of WL	N/A	N/A	N/A	N/A
14 <u>Wrestling</u> [741]	N/A	N/A	N/A	N/A	<u>Binge eating (% of sample)</u> : after weigh-in (11.9%), off-season (10.2%), after a match (9.9%) and prior to a match (3.2%)
75 <u>Wrestling</u> [78]	<u>Hydration (USG)</u> : normal range throughout the season	N/A	N/A	N/A	N/A

Ref sport group [n]	Anthropometry/Body composition and weight management	Biological parameters	Energy expenditure	Physical condition/performance	Eating behaviors and psychological status
4 <u>Wrestling</u> <u>collegiate</u> [63]	N/A	N/A	N/A	N/A	collegiate <u>Difficulty to 'make weight'</u> (% of sample): 56 <u>Psychological moods during WL</u> (% of sample): severe fatigue (75%), anger (66%), anxiety (33%), feelings of isolation (23%), depression (24%) and low self-esteem (12%) <u>Binge eating</u> (sum of 'always/often' and 'sometimes' answers, % of sample): after match (59%), after weigh-in (52%), days before match (35%) and during off-season (26%)
76 <u>Wrestling</u> [11]	<u>BW (kg)</u> : significant correlation between WG and season record, and positive correlation between WG and official weight <u>Skinfolds (mm)</u> : - triceps, abdomen, chest, suprailiac: (pre-WL = WG) > WL - subscapular, thigh: pre-WL > WL; WL = WG; pre-WL = WG	N/A	N/A	<u>Performance (fight issue)</u> : NS correlation between WG and fight issue	N/A
44 <u>Boxing</u> [25%] <u>BJJ</u> [6%] <u>Judo</u> [12%] <u>MMA</u> [11%] <u>MT/K</u> [12%] <u>TKD</u> [6%] <u>Wrestling</u> [27%] total [637]	<u>Number of WL in the last 2 years</u> : (BJJ (3 ± 3) = boxing (6 ± 6) = judo (5 ± 5) = MMA (4 ± 2) = MT/K (3 ± 4) = TKD (7 ± 5) < wrestling (16 ± 18)	N/A	N/A	N/A	N/A
94 <u>Jiu-jitsu, judo, karate, muay thai, TKD, silat</u> WC [43]	N/A	N/A	N/A	N/A	<u>Psychological moods during WL</u> (% sample): fatigue (69.2%), decreased vigor (50.8%), muscle cramps (46.2%), decreased concentration (43.1%), help in winning competition (41.5%), increased risk of injury (33.8%), increased depression (24.6%) and short-term memory loss (10.8%)
51 <u>Wrestling, judo, TKD</u> [14]	<u>Weight management declarations</u> : - the athlete is in his/her mind forced to gain weight in order to be at his/her best in the current weight-class - off-season: slight WG due to the temporary reduction in training frequency and intensity + less restrictive dietary	N/A	N/A	N/A	<u>Binge eating declarations</u> : magnitude of post-weigh-in binge eating depend on the time until the first match <u>Dietary declarations</u> : several athletes followed a well-thought nutritional plan post weigh-in to assure optimal recovery

Ref sport group [n]	Anthropometry/Body composition and weight management	Biological parameters	Energy expenditure	Physical condition/performance	Eating behaviors and psychological status
52 <u>Judo, TKD, wrestling</u> DIET [15]	<u>Weight management declarations:</u> - WG in order to physically overpower the opponent - larger BW than opponent results in an advantage regarding leverage, reach, power, and strength - weight regulation is linked to the traditions and culture of the sport - optimal nutrition a necessity in striving for competitive success	N/A	N/A	N/A	<u>Psychological values of weight regulation:</u> belonging, prestige, self-discipline, control, professionalism, focus, self-confidence, signal-power
Imposed WL conditions only					
40 <u>Boxing</u> [7]	<u>Exercise HR:</u> pre-WL = WG	N/A	<u>EE (kcal/min):</u> - SMR: pre-WL > WL - postprandial: pre-WL < WG <u>RER:</u> - SMR: pre-WL > WL - postprandial: pre-WL > WG <u>CHO oxidation (g/min):</u> - sleeping: pre-WL > WL - postprandial: pre-WL > WG <u>Lip oxidation (g/min):</u> - sleeping: pre-WL = WL - postprandial: pre-WL < WG	<u>Maximal oxygen uptake (VO₂ (mL/min)):</u> - low and mid-intensity running levels: pre-WL > WG - high-intensity running level: pre-WL = WG <u>RPE:</u> pre-WL = WG	N/A
53 <u>Boxing, judo</u> [10]	N/A	N/A	[pre-WL / WL / WG] <u>REE (kcal/d):</u> 1998 ± 242 / 1846 ± 261 / 1852 ± 243 <u>SMR (kcal/d):</u> 1822 ± 191 / 1587 ± 150* / 1734 ± 222	N/A	N/A
Imposed WG conditions only					
43 <u>Judo</u> DIET [10] non-DIET [10]	N/A	<u>Insulin (mUI/L):</u> DIET: pre-WL > WL; WL < WG non-DIET: pre-WL = WL; WL < WG <u>TG (mmol/L):</u> DIET: pre-WL < WL < WG non-DIET: pre-WL = WL; WL < WG <u>FFA (mmol/L):</u> DIET: (pre-WL = WG) < WL non-DIET: pre-WL = WL; WL > WG <u>Glucose (mmol/L):</u> DIET: pre-WL = WL; WL < WG non-DIET: pre-WL = WL; WL = WG <u>T3/T4:</u> DIET: pre-WL > WL; WL < WG non-DIET: pre-WL = WL; WL = WG	N/A	<u>Muscle strength (handgrip (kg)):</u> DIET: pre-WL > WL (-5%); WL > WG (-7%) non-DIET: pre-WL = WL; WL > WG (-8%); pre-WL > WG <u>Anaerobic work capacity:</u> same variations as handgrip strength were observed	<u>Psychological moods (POMS):</u> - Tension and fatigue: DIET: pre-WL < WL < WG non-DIET: pre-WL = WL; WL < WG - Anger: DIET: pre-WL < WL; WL = WG non-DIET: pre-WL = WL; WL = WG - Vigor: DIET: pre-WL > WL > WG non-DIET: pre-WL = WL; WL > WG - Depression and confusion: DIET and non-DIET: pre-WL = WL; WL = WG
Imposed WL and WG conditions					

Ref sport group [n]	Anthropometry/Body composition and weight management	Biological parameters	Energy expenditure	Physical condition/performance	Eating behaviors and psychological status
50 <u>Wrestling</u> [8]	Body volume (L): pre-WL < WL; WL > WG Thoracic gaz volume (L): pre-WL > WL; WL < WG	N/A	N/A	N/A	N/A
41 <u>Wrestling</u> [10]	BMC (kg): pre-WL = WL = WG-3 Hydration (USG; osmotic pressure (mOs/mL)): (pre-WL = WG-3) > WL	n = 9 Insulin (μU/mL): pre-WL = WL; WL < WG-3; pre-WL = WG-3 Glucose (mg/dL): (pre-WL = WG-3) > WL TG (mg/dL): pre-WL < (WL = WG-3) FFA (mEq/L): total-C, HDL-C, LDL-C (mg/dL): (pre-WL = WG-3) < WL	N/A	N/A	N/A
95 <u>Wrestling</u> [5, placebo and creatine groups are the same sample]	N/A	Glucose (mmol/L): placebo and creatine: pre-WL = WL = WG	N/A	Muscle strength (leg): - work submax (J): placebo: pre-WL = WL = WG creatine: pre-WL > WL; WL = WG; pre-WL = WG - work max (J): placebo: pre-WL = WL = WG creatine: pre-WL = WL and WG; WL < WG - total work (J): placebo: pre-WL > WL; WL = WG; pre-WL = WG creatine: pre-WL = WL = WG	N/A
71 <u>Wrestling</u> HC [6] MC [6]	N/A	Glucose (mmol/L): MC and HC: pre-WL = WL and WG MC vs HC: MC < HC	N/A	Anaerobic work capacity: - total work (J), average power (W): MC and HC: pre-WL > WL; pre-WL = WG MC vs HC: MC < HC - peak power (W): MC and HC: pre-WL = WL and WG MC vs HC: NS	N/A
103 <u>Judo</u> wrestling [10, gradual and rapid WL are the same sample]	N/A	N/A	N/A	Anaerobic work capacity (power (W/kg)): gradual WL: pre-WL-1 = WL-1 rapid WL: pre-WL-2 = WL-2 gradual WL vs rapid WL: NS Vertical jump (cm): - no extra weight: gradual WL: pre-WL-1 = WL-1 rapid WL: pre-WL-2 = WL-2 gradual WL vs rapid WL: NS - with 50% extra weight: gradual WL: pre-WL-1 < WL-1 rapid WL: pre-WL-2 = WL-2 gradual WL vs rapid WL: NS - with 100% extra weight: gradual WL: pre-WL-1 = WL-1 rapid WL: pre-WL-2 = WL-2 gradual WL vs rapid WL: gradual WL (WL-1) > rapid WL (WL-2)	N/A

Ref sport group [n]	Anthropometry/Body composition and weight management	Biological parameters	Energy expenditure	Physical condition/performance	Eating behaviors and psychological status
Strength and conditioning sports					
Usual athletes' methods of WL and WG [not imposed by the study design]					
15 <u>Body building</u> [45]	N/A	N/A	N/A	N/A	<u>Psychological moods during WL (% of sample):</u> irritability (55%), anger (47%), fatigue (46%), anxiety (33%), depression (33%) and isolation (31%) <u>Binge eating (sum of 'always' and 'sometimes' answers, % of sample):</u> after event (46%), off-season (38%), one week before event (28%), two weeks before event (23%) and the day of event (13%)
16 <u>Body building</u> [1]	<u>Total skinfold (mm):</u> (pre-WL = WG-4) > WL-3	N/A	[pre-WL / WL-1 / WL-2 / WL-3 / WG-1 / WG-2] <u>Exercise EE (kcal/d)^{NAS}:</u> NR / 484 / 459 / 440 / 355 / 378 <u>Energy availability (kcal/kg FFM)^{NAS}:</u> 32.7 / 28.2 / 23.2 / 27.3 / 36.5 / 35.1	N/A	N/A
80 <u>Body building</u> [1]	N/A	N/A	[pre-WL / WL-6 / WG-5] <u>REE (kcal/d)^{NAS}:</u> 2275.4 / 1910.1 / 2120	<u>Anaerobic work capacity (absolute (W) and relative (W/kg) peak and average power)^{NAS}:</u> ↓ during WL period; ↑ during WG period	N/A
81 <u>Body building</u> [1]	N/A	<u>Insulin (µU/mL):</u> WL-3; WL-6 < reference range <u>Glucose (mg/dL):</u> WL-3 < reference range <u>Total-C (mg/dL):</u> pre-WL; WL-3; WL-6; WG-3 > reference range <u>TG, HDL-C and LDL-C (mg/dL):</u> no value out of reference range	[pre-WL / WL-3 / WL-6 / WG-3] <u>REE (kcal/d)^{NAS}:</u> 2401 / 1523 / 1281 / 1604	<u>Maximal oxygen uptake (VO2 peak (L/min) and critical power (W))^{NAS}:</u> - absolute: ↓ during WL period; ↑ during WG period - relative (/kg of BW): no apparent changes <u>Muscle strength (1RM (kg))^{NAS}:</u> - absolute: ↓ during WL period (squat: -13.8%, bench press: -8.4%, deadlift: -7.0%); ↑ during WG period - relative (/kg of BW): no apparent changes	N/A
82 <u>Body building</u> [1]	N/A	N/A	[pre-WL / WL-1 / WL-2 / WL-3 / WL-4 / WL-5 / WG-1 / WL-6 / WL-7 / WG-2 / WG-3 / WG-4] <u>REE (kcal/d)^{NAS}:</u> 1345 / 1474 / 1236 / 1350 / 1351 / 1202 / 1274 / 1119 / 1311 / 1240 / 1363 / 1435 [pre-WL / WL-5 / WG-1 / WG-2 to 4] <u>RER^{NAS}:</u> 0.74 / 0.82 / 0.74 / 0.85	<u>Muscle strength^{NAS}:</u> - concentric and eccentric peak force (N): pre-WL = WL periods = WG periods - rate of force development in first 200ms on squat device (N/s): pre-WL > (WL-1 = WL-3 to 5 = WG-2 to 4); WL-1 = WL-2 = WL-3; WL-5 < WG-1	N/A

Ref sport group [n]	Anthropometry/Body composition and weight management	Biological parameters	Energy expenditure	Physical condition/performance	Eating behaviors and psychological status
39 Fitness DIET [27] non-DIET [23]	<p><u>FM:</u> - Android FM (kg): DIET: (pre-WL = WG) > WL non-DIET: pre-WL = WL = WG DIET vs non-DIET (%): ΔWL-preWL and ΔWG-WL: DIET > non-DIET; ΔWG-preWL: DIET = non-DIET</p> <p>- Triceps fat thickness (cm): DIET: (pre-WL = WG) > WL non-DIET: pre-WL = WL = WG DIET vs non-DIET (%): ΔWL-preWL, ΔWG-WL and ΔWG-preWL: DIET > non-DIET</p> <p>- Vastus lateralis fat thickness (cm): DIET: pre-WL > WG > WL non-DIET: pre-WL = WL = WG DIET vs non-DIET (%): ΔWL-preWL, ΔWG-WL and ΔWG-preWL: DIET > non-DIET</p> <p><u>FFM:</u> - Triceps muscle thickness (cm): DIET and non-DIET: pre-WL = WL = WG DIET vs non-DIET (%): ΔWL-preWL, ΔWG-WL, and ΔWG-preWL: DIET = non-DIET</p> <p>- Total bones (kg): DIET: pre-WL > WL; WL = WG; pre-WL = WG non-DIET: pre-WL = WL; WL = WG; pre-WL < WG DIET vs non-DIET (%): ΔWL-preWL: DIET > non-DIET; ΔWG-WL: DIET = non-DIET; ΔWG-preWL: DIET < non-DIET</p> <p><u>Resting HR (bpm):</u> DIET: pre-WL > (WL = WG) non-DIET: pre-WL = WL = WG DIET vs non-DIET (%): ΔWL-preWL: DIET > non-DIET, ΔWG-WL and ΔWG-preWL: DIET = non-DIET</p>	N/A	N/A	<p><u>Muscle strength (1RM (N)):</u> - leg press (n DIET = 25 and n non-DIET = 26): DIET: pre-WL = WL; WL = WG; pre-WL < WL non-DIET: pre-WL = WL = WG DIET vs non-DIET: ΔWL-pre-WL, ΔWG-WL and ΔWG-pre-WL: NS</p> <p>- bench press (n DIET = 20 and n non-DIET = 23): DIET: pre-WL = WL = WG non-DIET: pre-WL = WL; WL = WG; pre-WL > WL DIET vs non-DIET: ΔWL-preWL: DIET > non-DIET, ΔWG-WL: DIET < non-DIET, and ΔWG-preWL: DIET = non-DIET</p> <p><u>Vertical jump (cm, n DIET = 27 and n non-DIET = 23):</u> DIET and non-DIET: pre-WL = WL = WG DIET vs non-DIET: ΔWL-pre-WL, ΔWG-WL and ΔWG-pre-WL: NS</p>	<p><u>Psychological moods (POMS: vigor, confusion, anger, fatigue, depression, and tension scores):</u> DIET and non-DIET: pre-WL = WL = WG DIET vs non-DIET: NS</p>
54 Fitness DIET [25] non-DIET [17]	<p><u>Waist circumference (cm):</u> DIET: pre-WL > WL and WG non-DIET: pre-WL = WL; pre-WL > WL</p> <p><u>Android fat (g):</u> DIET: pre-WL > WL; pre-WL = WL non-DIET: pre-WL = WL and WL</p>	N/A	N/A	N/A	N/A

Ref sport group [n]	Anthropometry/Body composition and weight management	Biological parameters	Energy expenditure	Physical condition/performance	Eating behaviors and psychological status
55 Fitness DIET [25] non-DIET [17] FINRISK [58]	Waist circumference (cm): DIET: pre-WL > WL and WG non-DIET: pre-WL = WL; pre-WL > WG DIET and non-DIET vs FINRISK: NS	N/A	N/A	N/A	N/A
42 Fitness DIET [25] non-DIET [17]	N/A	Glucose (mmol/L): DIET and non-DIET: pre-WL = WL and WG DIET vs non-DIET: NS	N/A	N/A	N/A
Imposed WL conditions only					
97 Body building FLEX [11] RIGID [12]	N/A	N/A	[pre-WL / WL / WG] REE (kcal/d): FLEX: 1816 ± 229 / 1805 ± 169 / 1827 ± 257 RIGID: 1576 ± 350 / 1631 ± 377 / 1649 ± 375 FLEX vs RIGID: NS	N/A	Eating behavior (TFEQ: cognitive restraint, disinhibition and hunger scores): FLEX and RIGID: pre-WL = WL = WG FLEX vs RIGID: NS
Combat sports + strength and conditioning sports + other sports					
101 Boxing [22] Judo [16] LW rowing [33] Wrestling [33] DIET [104] non-DIET [38]	Number of diets during career: LW rowing (4.9 ± 4.2) < (judo (59.3 ± 48.7) = wrestling (67.7 ± 52.8) < boxing (72.3 ± 37.7))	N/A	N/A	N/A	EAT-26 score, oral control and food preoccupation subscale: DIET > non-DIET Quality of life: elite retired athletes have a high physical activity levels and low eating disorder scores
102 Boxing, weight lifting, wrestling WC [273] non-WC [1093] NA [667]	BMI: WC significantly more likely to have obesity than NA at all time points	N/A	N/A	N/A	Dietary (high-fat milk consumption): non-WC < WC < NA
77 Rowing m [12] f [6]	Total skinfold (mm): m: pre-WL > WL-1 and WL-2; pre-WL = WG f: pre-WL > WL-2; pre-WL = WG	N/A	N/A	N/A	N/A
Soldiers					
Usual soldiers WL and WG habits					

Ref sport group [n]	Anthropometry/Body composition and weight management	Biological parameters	Energy expenditure	Physical condition/performance	Eating behaviors and psychological status
104 Soldiers WC [190] non-WC [385]	BMI: significant correlation between WC and BMI (+1.09 point higher BMI), and between dieting and BMI (+1.67 point higher BMI)	N/A	N/A	N/A	N/A
Imposed WL conditions					
37 Soldiers [10]	N/A	N/A	N/A	<u>Agility (Illinois test (sec)), maximal oxygen uptake (beep test (stage)) and endurance (heel clap (rep))</u> : pre-WL < (WG-1 = WG-2) <u>Anaerobic work capacity (300-yd shuttle run (sec))</u> : pre-WL = WG-1; pre-WL > WG-2; WG-1 = WG-2 <u>Muscle strength</u> : - metronome push up (rep): pre-WL > WG-1; pre-WL = WG-2; WG-1 = WG-2 - pull up (rep): pre-WL > WG-2 > WG-1 - 185-lbs bench press (rep), 225-lbs deadlift (rep): pre-WL = WG-1 = WG-2	N/A
Imposed WL and WG conditions					
35 Soldiers g1 [55] g2 [50] g2sub [10]	<u>Waist circumference (cm)</u> : g1 : pre-WL > WL g2 : (pre-WL = WG) > WL	<u>Insulin, glucose and TG (mmol/L)</u> : g1 : pre-WL > WL-1; WL-1 = WL-2 = WL-3 = WL-4 <u>total-C (mg/dL)</u> : g1 : (pre-WL = WL-1) < WL-3 < WL-4; WL-1 = WL-2; WL-2 = WL-3 g2 : (pre-WL = WL-2) < (WG-2 = WL-4); WL-2 = WL-3; WG-2 = WL-3 g1 vs g2 : NS from pre-WL to WL-4 <u>LDL-C (mmol/L)</u> : g1 and g2 : ↓ from pre-WL and WL-1; ↑ from WL-1 to WL-4 <u>HDL-C (mg/dL)</u> : g1 : (pre-WL = WL-1) < (WL-2 = WL-3); WL-2 = WL-4; WL-3 < WL-4 g2 : pre-WL < (WL-2 = WG-2) < (WL-3 = WL-4) g2sub : pre-WL = WG-4; WL-4 > WG-4 g1 vs g2 : NS from pre-WL to WL-4 <u>T3 (ng/dL)</u> : g1 : pre-WL > WL-1 > (WL-3 = WL-4); WL-1 = WL-2; WL-2 = WL-3 g2 : (pre-WL = WG-2) > (WL-2 = WL-3 = WL-4) g2sub : (pre-WL = WG-4) < WL-4 g1 vs g2 : g1 < g2 at WL-3 and WL-4	N/A	N/A	<u>Binge eating (+6mo after Range course)</u> : g1 : hyperphagia peaks at 1mo and all parameters back to normal +6mo post-training g2 : complaints about weight-gain overshoot after the 1st mo

Ref sport group [n]	Anthropometry/Body composition and weight management	Biological parameters	Energy expenditure	Physical condition/performance	Eating behaviors and psychological status
36 <u>Soldiers</u> [10]	N/A	<u>Glycerol (μmol/L):</u> pre-WL = WL = WG <u>FFA (mmol/L):</u> WG < pre-WL < WL <u>HDL-C (mmol/L):</u> (pre-WL = WG) < WL	N/A	<u>Muscle strength (maximal lift capacity (kg); explosive power (W)):</u> (pre-WL = WG) > WL <u>Vertical jump (cm):</u> (pre-WL = WG) > WL	N/A
34 <u>Soldiers</u> LOW [19] HIGH [19]	N/A	N/A	<u>REE and exercise EE (kcal/d):</u> LOW vs HIGH: NS at WL	<u>Anaerobic work capacity (mean and peak power (W)):</u> LOW and HIGH: pre-WL > WG > WL <u>Muscle strength (leg. bench press 1RM (kg)):</u> LOW and HIGH: pre-WL > WG > WL <u>Vertical jump (cm):</u> LOW and HIGH: pre-WL > (WL = WG)	N/A

Quantitative results were given for studies included in the additional meta-analysis (grey cells), or for studies with non-apparent statistical results. Time points between parentheses have the same statistical signification compared with other time points on the other side of the > or < symbol. = : non-significant result; > : significant decrease; ↓: trend of decreasing results; < : significant increase; ↑: trend of increasing results; *: significant difference from pre-WL; \$: significant difference with previous time point; †: significant difference with all other groups from the same article; 1RM: one maximal voluntary contraction; BMC: bone mineral content; BMD: bone mineral density; BMI: body mass index; BW: body weight; d: day; DIET: dieters; EAT: eating attitudes test; EWI: evening weigh-in; f: female; FFA: free fatty acid; h: hour; HDL/LDL-C: high/low density lipoprotein; HR: heart rate; LW/MW/HW: lightweight/middleweight/heavyweight; METH: metabolic equivalent hours; mo: month; MT/K: muay thai/kickboxing; N/A: not-applicable; NA: non-athletes; ^{NAS}: non-apparent statistics; NR: not reported; NS: no significant result; POMS: profile of moods questionnaire; REE: resting energy expenditure; RER: respiratory exchange rate; RPE: rating of perceived exertion; RWLQ: rapid weight loss questionnaire; SD: standard deviation; SMR: sleeping metabolic rate; SR: significant result; TFEQ: three factor eating questionnaire; TG: triglycerides; UOSM: urine osmolality; USG: urine specific gravity; Ref: reference number of the article; VO₂: oxygen/carbon dioxide consumption; WC: weight-cyclers; WD: weight difference; WG: weight gain; WL: weight loss.

Fig. S1 a)

References about combat sports athletes

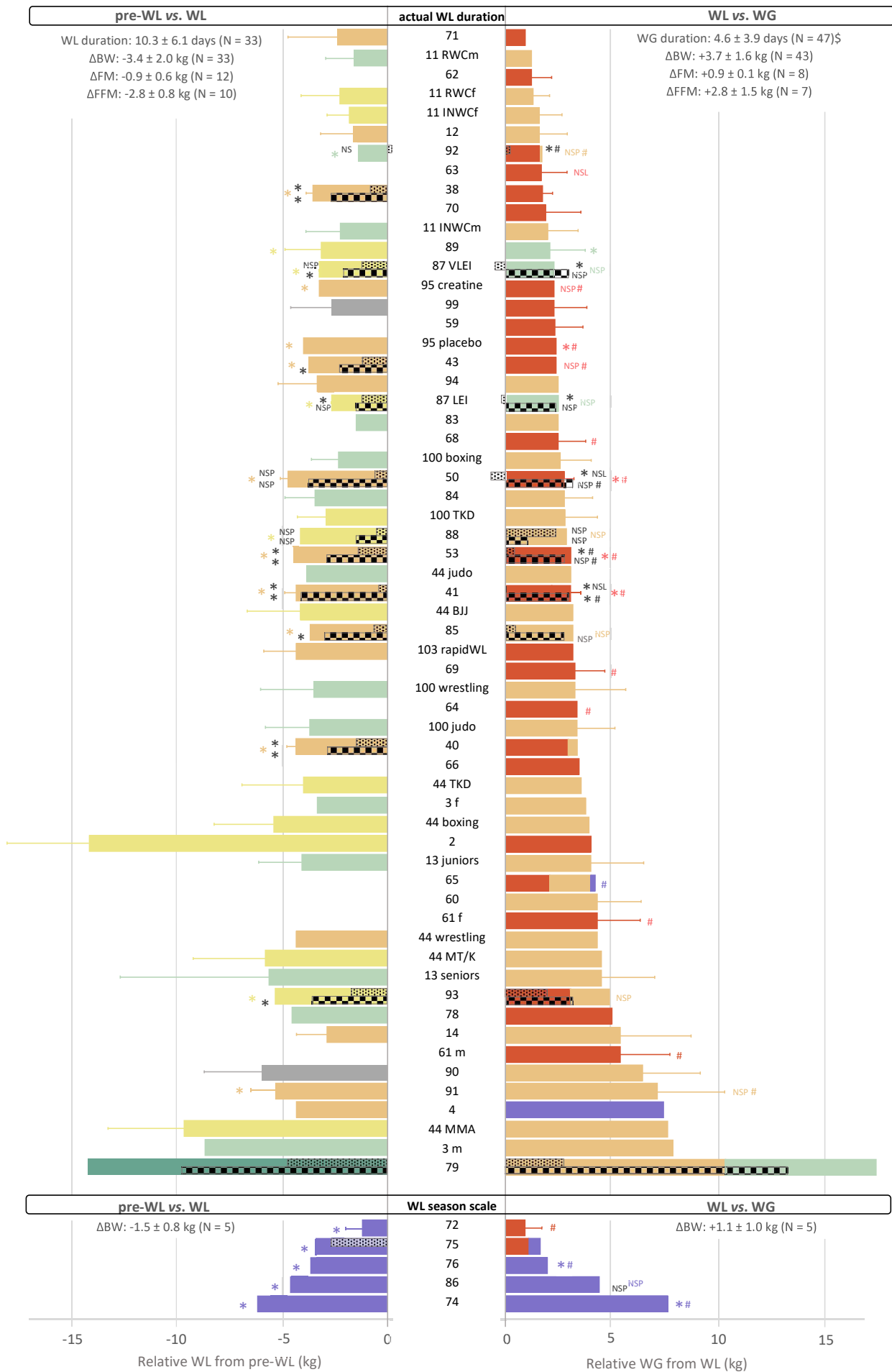


Fig. S1 b)

References about strength and conditioning athletes

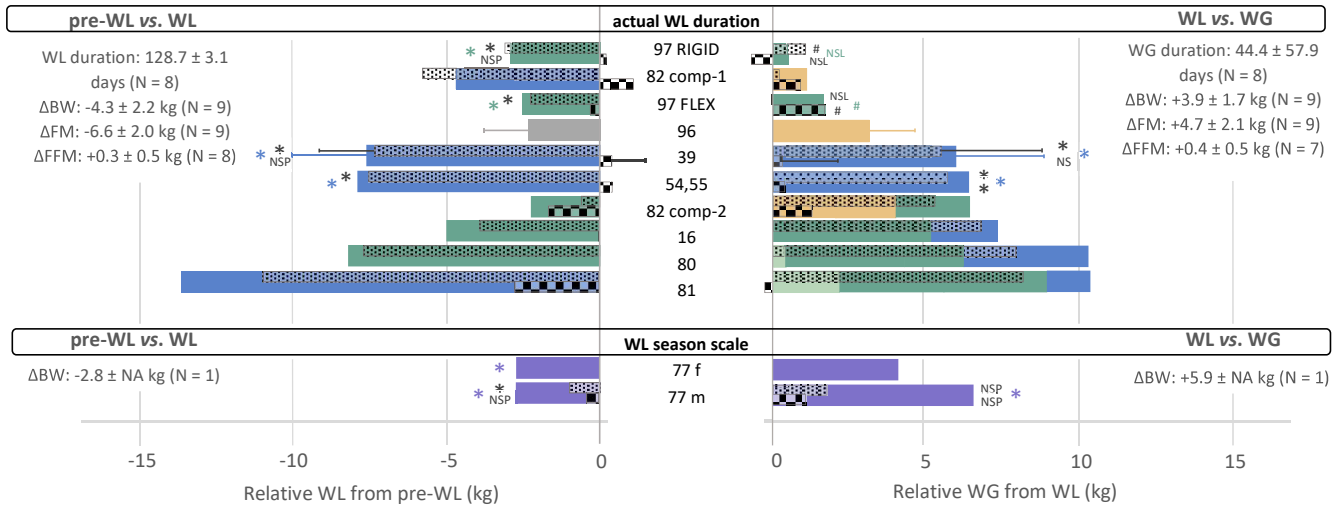
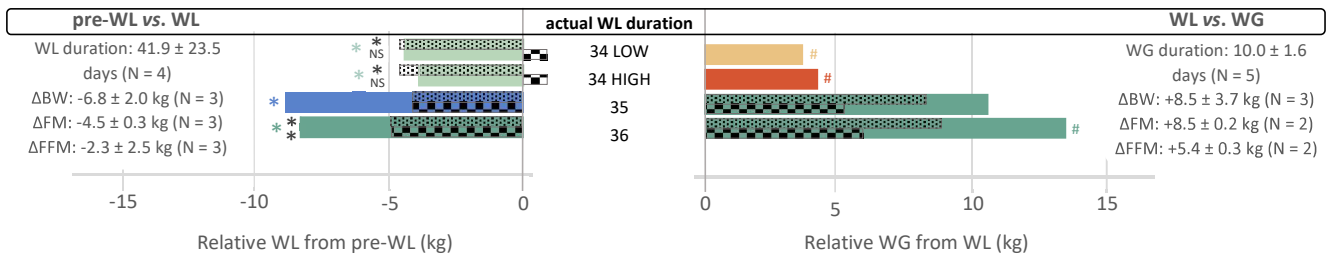


Fig. S1 c)

References about soldiers



Legend:

Not mentioned groups indicates the results for the total dieter cohort of the study

Relative BW variations by total WL and WG duration:

-]0;1] day
-]1;7] days
-]7;14] days
-]14;31] days
-]1;3] months
-]3;7] months
- pre-mid(WL)/mid-post(WG)-season
- NR

Total relative body composition:

- FM
- FFM

Missing values indicates not applicable or not reported data in the study

Significant difference of BW, FM or FFM:

- * from pre-WL
- # from WL

No significant difference of BW, FM or FFM:

- NSP: from pre-WL
- NSL: from WL

Global results presented in rectangles with rounded edges correspond to the subject-adjusted means (N articles)

§ WG time points taken after the season were not considered

Fig. S1 Relative BW, FM, and FFM evolution per WL and WG duration for a) combat sports, b) strength and conditioning sports, and c) soldiers.

Description of the Supplementary Figure S1 reading:

Relative BW, FM, and FFM evolution per WL and WG duration for a) combat sports, b) strength and conditioning sports, and c) soldiers (BW: body weight, FFM: fat-free mass, FM: fat mass, WG: weight gain, WL: weight loss).

"This figure was constructed to get an overall view of the data on weight changes in kg (BW, FM, and FFM).

The items were categorized by type of practice: a) combat sports, b) strength sports, and c) soldiers. The references of the articles are indicated in the middle column. Where necessary, the name of the subgroup of subjects has been specified.

Horizontal histograms oriented to the left represent the amount of weight lost, while those oriented to the right represent the amount of weight regained. Among them, filled histograms correspond to changes in BW, histograms with a dot pattern correspond to changes in FM, and histograms with a checkerboard pattern correspond to changes in FFM. The duration of WL and WG was color-coded as explained in the figure legend. When the duration of WL or WG was on a sport season scale (e.g., pre-sport season, mid-sport season, end of sport season), the data were grouped together at the bottom of the figure for each sport type.

The statistical results specific to each study were reported with the symbols: *: significant result from pre-WL, #: significant result from WL, NSP: no significant results from pre-WL, and NSL: no significant results from WL.

To consider durations and weight variations in BW, FM and FFM in a general way, weighted-means and standard deviations by the number of subjects per study were calculated. These are presented at the top of each sub-figure: on the left for WL relative to pre-WL, and on the right for WG relative to WL."

ANNEXE 3

Questionnaire Answ'her (version originale en Français)

Supplementary material 1 de l'Étude 1, Axe II du manuscrit de thèse.

QUESTIONNAIRE ANSW'HER ORIGINAL VERSION

Ce questionnaire est à destination de sportives âgées entre 18 et 45 ans ayant au moins 2 ans de pratique sportive, 4 heures minimum par semaine. Il a pour but de reporter votre statut hormonal et pondéral.

Les données renseignées resteront strictement confidentielles.

Si vous prenez ou avez pris une(des) contraception(s), son(leurs) nom(s) vous sera(seront) demandé(s).

Temps de réponse estimé: 15 min.

Pour toute question ou remarque, une réponse vous est dédiée à la fin de ce questionnaire. Sinon, vous pouvez nous contacter par mail à sarah.bagot@uca.fr.

Note importante:

Pour faire avancer la recherche sur ce sujet, il est important de répondre à ce questionnaire au calme, avec le plus de rigueur possible.

***Obligatoire**

I - Informations générales

Vos informations personnelles resteront strictement confidentielles

Nom Prénom *

Mail *

1. Pays *

2. Âge *

Merci d'entrer une réponse chiffrée uniquement. Si besoin, la virgule doit être indiquée par un point.

3. Taille (cm) *

Merci d'entrer une réponse chiffrée uniquement. Si besoin, la virgule doit être indiquée par un point.

4. Poids (kg) *

Merci d'entrer une réponse chiffrée uniquement. Si besoin, la virgule doit être indiquée par un point.

5. Avez-vous déjà eu vos premières règles? *

Une seule réponse possible.

a Oui

b Non *Passer à la question 46*

6. Si non, existe-t-il une raison particulière?

II - Cycle menstruel et contraception

Cette partie a pour objectif de décrire votre cycle menstruel et les éventuels moyens de contraception que vous utilisez.

7. Quel âge aviez-vous lors de vos premières règles ? *

Merci d'entrer une réponse chiffrée uniquement. Si besoin, la virgule doit être indiquée par un point.

8. Quelle est la durée moyenne de votre cycle menstruel ? *
- C'est à dire le nombre de jours entre le premier jour des règles et le dernier jour avant les règles suivantes.

Une seule réponse possible.

- a Moins de 21 jours
b Entre 21 et 35 jours inclus
c Plus de 35 jours

9. Quelle est la durée moyenne de vos règles ? *

Une seule réponse possible.

- a Moins de 4 jours
b 4 - 5 jours
c 6 jours
d Plus de 6 jours

10. À quand remonte le premier jour de vos dernières règles ? *

Exemple : 7 janvier 2019

11. Avez-vous déjà eu un arrêt de plus de 3 mois de vos règles (hors grossesse)? *

Une seule réponse possible.

- a Oui
b Non

12. Ces 6 derniers mois, vos règles sont-elles régulières (moins de 6 jours d'avance ou de retard) ? *

Si vous n'avez pas eu vos règles au cours de ces 6 derniers mois, veuillez sélectionner "Autre" et, si vous le pouvez, préciser pourquoi vous avez une interruption de vos règles.

Une seule réponse possible.

- a Oui
b Non
c Autre : _____

13. Avez-vous déjà eu des retards ou avances dans vos règles ces 3 dernières années (plus ou moins 6 jours) ?

Si vous avez eu vos premières règles il y a moins de 3 ans, veuillez passer à la question suivante.

Une seule réponse possible.

- a Je n'ai pas eu mes règles au cours de ces 3 dernières années
b Tout le temps
c Souvent
d Parfois
e Rarement
f Jamais

14. Etes-vous ou avez-vous déjà été enceinte? *

Plusieurs réponses possibles.

Plusieurs réponses possibles.

- a Oui, je le suis actuellement
b Oui, je l'ai été par le passé
c Non

15. Si oui, combien de grossesse(s) avez-vous eue(s) (sans prendre en compte votre éventuelle grossesse actuelle) ?

16. Si oui, à quand remonte le début de votre dernière grossesse (sans prendre en compte votre éventuelle grossesse actuelle) ?

Exemple : 7 janvier 2019

17. Si vous êtes actuellement enceinte, à combien de semaines d'aménorrhée êtes-vous ?

L'aménorrhée correspond à l'absence de règles. Merci d'entrer une réponse chiffrée uniquement. Si besoin, la virgule doit être indiquée par un point.

18. Actuellement, prenez-vous un moyen de contraception ? *

Une seule réponse possible.

- a Oui *Passer à la question 19*
b Non, mais j'en ai pris par le passé *Passer à la question 28*
c Non, je n'en ai jamais pris *Passer à la question 33*

Description de votre contraception

19. Quel(s) moyen(s) de contraception prenez-vous actuellement? *

Plusieurs réponses possibles.

Plusieurs réponses possibles.

- a Pilule
b Implant
c Stérilet au cuivre
d Stérilet hormonal
e Patch contraceptif
f Anneau vaginal
g Autre : _____

20. Précisez le nom de votre(vos) contraception(s) *

21. Depuis combien de temps utilisez-vous ce(s) moyen(s) de contraception? *
Merci de préciser l'unité (jours, semaines, mois, années).

22. Si vous prenez la pilule, à quelle fréquence vous arrive-t-il D'OUBLIER de prendre un comprimé ? *

Sans prendre en compte le comprimé placebo pris en période de règles.

Une seule réponse possible.

- a Tout le temps (plus de 7 fois par cycle)
b Souvent (2 à 7 fois par cycle)
c Parfois (1 fois par cycle)
d Rarement (1 fois tous les 2 cycles)
e Jamais (0 fois par cycle)

23. Par le passé, avez-vous déjà utilisé d'autre(s) moyen(s) de contraception? *

Plusieurs réponses possibles.

Plusieurs réponses possibles.

- a Pilule
- b Implant
- c Stérilet au cuivre
- d Stérilet hormonal
- e Patch contraceptif
- f Anneau vaginal
- g Je n'ai jamais pris d'autre moyen de contraception
- h Autre : _____

24. Si oui, précisez le nom de votre(vos) ancienne(s) contraception(s) et pour chacune d'entre elles, la durée de son utilisation (en jours, mois, années)

25. Si oui, pour quelles raisons avez-vous changé?

26. Si vous prenez ou avez pris la pilule, vous est-il déjà arrivé d'enchaîner les plaquettes, ou de sauter la prise de placebo pour enchaîner les plaquettes dans le cas d'une pilule continue ? *

Si vous prenez une pilule continue avec prise de placebo, répondre 'non'.

Une seule réponse possible.

- a Oui
- b Non
- c Je ne suis pas concernée

27. Si oui, pourquoi?

Passer à la question 33

Votre passé contraceptif

28. Par le passé, avez-vous déjà utilisé l'un de ces moyens de contraception? *

Plusieurs réponses possibles.

Plusieurs réponses possibles.

- a Pilule
- b Implant
- c Stérilet au cuivre
- d Stérilet hormonal
- e Patch contraceptif
- f Anneau vaginal
- g Autre : _____

29. Précisez le nom de votre(vos) ancienne(s) contraception(s) et pour chacune d'entre elles, la durée de son utilisation (en jours, mois, années) *

30. Pour chacune d'entre elles, pouvez-vous indiquer pour quelle(s) raison(s) vous l'avez arrêtée *

31. Si vous prenez ou avez pris la pilule, vous est-il déjà arrivé d'enchaîner les plaquettes, ou de sauter la prise de placebo pour enchaîner les plaquettes dans le cas d'une pilule continue ? *

Si vous prenez une pilule continue avec prise de placebo, répondre 'non'.

Une seule réponse possible.

- a Oui
b Non
c Je ne suis pas concernée

32. Si oui, pourquoi?

III - Cycle menstruel actuel et symptômes associés

Cette partie va permettre de décrire les éventuels symptômes que vous pouvez ressentir au cours des différentes phases de votre cycle menstruel, ainsi que les moyens mis en place pour les atténuer.

En cas de grossesse, merci d'indiquer vos réponses pour vos précédents cycles menstruels (avant grossesse).

AU COURS DE LA SEMAINE PRÉCÉDANT VOS RÈGLES:

33. Habituellement, au cours de la semaine précédant vos règles, à quelle intensité * ressentez-vous chacun des symptômes suivants sur une échelle de 0 (pas du tout) à 5 (très fort)?

En cas d'absence de règles (hors grossesse), merci d'indiquer zéro à toutes les questions et de cocher la réponse "je ne suis pas concernée (absence de règles)" à la question suivante. En cas de grossesse, merci d'indiquer vos réponses pour vos périodes de règles avant grossesse.

Une seule réponse possible par ligne.

	0	1	2	3	4	5
a Appétit augmenté/faim	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b Appétit diminué	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c Ballonnements	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d Bouffées de chaleur	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e Constipation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f Douleurs abdominales/pelviennes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g Douleurs articulaires	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
h Douleurs dans la poitrine	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
i Douleurs musculaires	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
j Envies pressantes d'uriner	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
k Fatigue	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
l Jambes lourdes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
m Maux de dos	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
n Maux de tête/migraines	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
o Nausées	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
p Perte de poids	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
q Prise de poids	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

r Problèmes de peau/Acné	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
s Changements d'humeur	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
t Vertiges	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

34. Si vous avez d'autre(s) symptôme(s) au cours de la semaine précédant vos règles non mentionnés précédemment, merci de les préciser et de noter leur intensité entre 1 (très faible) et 5 (très fort) :

35. Arrivez-vous à soulager ces symptômes? *

Une seule réponse possible.

- a Oui totalement
- b Oui partiellement
- c Non
- d Je n'ai pas de symptôme
- e Je ne suis pas concernée (absence de règles)
- f Je n'en ressens pas le besoin

36. Si oui, comment vous y prenez-vous pour les soulager?

PENDANT VOTRE PÉRIODE DE RÈGLES:

37. Habituellement, pendant vos règles, à quelle intensité ressentez-vous chacun des symptômes suivants sur une échelle de 0 (pas du tout) à 5 (très fort)? *

En cas d'absence de règles (hors grossesse), merci d'indiquer zéro à toutes les questions et de cocher la réponse "je ne suis pas concernée (absence de règles)" à la question suivante. En cas de grossesse, merci d'indiquer vos réponses pour vos périodes de règles avant grossesse.

Une seule réponse possible par ligne.

	0	1	2	3	4	5
a Appétit augmenté/faim	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b Appétit diminué	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c Ballonnements	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d Bouffées de chaleur	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e Constipation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f Douleurs abdominales/pelviennes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g Douleurs articulaires	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
h Douleurs dans la poitrine	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
i Douleurs musculaires	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
j Envies pressantes d'uriner	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
k Fatigue	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
l Jambes lourdes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
m Maux de dos	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
n Maux de tête/migraines	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
o Nausées	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
p Perte de poids	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
q Prise de poids	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

r	Problèmes de peau/Acné	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
s	Changements d'humeur	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
t	Vertiges	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

IV - Cycle menstruel et activité sportive

En cas de grossesse, merci d'indiquer vos réponses pour vos précédents cycles menstruels.

38. Si vous avez d'autre(s) symptôme(s) pendant vos règles non mentionnés précédemment, merci de les préciser et de noter leur intensité entre 1 (très faible) et 5 (très fort) :

39. Arrivez-vous à soulager ces symptômes ? *

Une seule réponse possible.

a Oui totalement

b Oui partiellement

c Non

d Je n'ai aucun symptôme

e Je ne suis pas concernée (absence de règles)

f Je n'en ressens pas le besoin

40. Si oui, comment vous y prenez-vous pour les soulager?

41. Sur l'échelle suivante, indiquez dans quelle mesure votre cycle menstruel impacte votre(vos) activité(s) sportive(s) ? *

Une seule réponse possible.

- a Aucun impact
- b Faible impact
- c Impact moyen
- d Impact fort
- e Impossibilité de pratiquer mon(mes) activité(s) sportive(s)

42. Sur l'échelle suivante, indiquez dans quelle mesure votre cycle menstruel impacte vos performances sportives ? *

Une seule réponse possible.

- a Aucun impact
- b Faible impact
- c Impact moyen
- d Impact fort
- e Impossibilité de pratiquer mon(mes) activité(s) sportive(s)

43. S'il a un impact, le décririez-vous comme étant:

Une seule réponse possible.

- a Positif (performances augmentées)
- b Négatif (performances diminuées)
- c Autre : _____

44. Si vous avez été vaccinée contre la COVID-19 en 2021, avez-vous remarqué des * changements au niveau de votre cycle menstruel ?

Une seule réponse possible.

- a Oui
- b Non
- c Je ne suis pas concernée

45. Si oui, lesquels ?

V - Pratique sportive

Cette partie a pour but de décrire votre activité sportive principale, c'est à dire celle que vous pratiquez principalement.

Si vous êtes enceinte, merci d'indiquer vos réponses correspondant à la saison sportive précédente.

46. Quel sport pratiquez-vous principalement? *

47. À quel âge avez-vous commencé à pratiquer ce sport? *

Merci d'entrer une réponse chiffrée uniquement. Si besoin, la virgule doit être indiquée par un point.

48. Combien de séances effectuez-vous par semaine? *

Merci d'entrer une réponse chiffrée uniquement. Si besoin, la virgule doit être indiquée par un point.

49. Quelle est la durée moyenne de ces séances (en minutes)? *

Merci d'entrer une réponse chiffrée uniquement.

50. Quel est le plus haut niveau que vous ayez atteint en compétition? *

Une seule réponse possible.

- a Je n'ai jamais fait de compétition
- b Départemental
- c Régional
- d National
- e International (Européen ou autre, à échelle inférieure que mondiale)
- f Mondial
- g Olympique
- h Autre : _____

51. Si vous pratiquez ou avez pratiqué la compétition, à quel âge avez-vous démarré?

Merci d'entrer une réponse chiffrée uniquement. Si besoin, la virgule doit être indiquée par un point.

52. Si vous avez arrêté la compétition, quel âge aviez-vous?

Merci d'entrer une réponse chiffrée uniquement. Si besoin, la virgule doit être indiquée par un point.

VI - Gestion de poids

Si vous êtes enceinte, merci d'indiquer vos réponses correspondant à la saison sportive précédente.

53. Réalisez-vous ou avez-vous déjà réalisé des variations de poids INTENTIONNELLEMENT OU NON-INTENTIONNELLEMENT au cours de votre saison sportive ? *

Une seule réponse possible.

- a Oui, j'en réalise toujours actuellement *Passer à la question 55*
- b Oui, mais je n'en réalise plus *Passer à la question 55*
- c Non, mais j'envisage d'en réaliser *Passer à la question 65*
- d Je n'ai jamais fait de variations de poids (volontaires ou non volontaires) et je ne compte pas en faire (répondre "je ne suis pas concernée" à la question suivante)

54. Avez-vous réalisé / réalisez-vous / souhaitez-vous réaliser ces variations de poids : *

Plusieurs réponses possibles.

Plusieurs réponses possibles.

- a Intentionnellement pour des raisons de santé
- b Intentionnellement pour des raisons esthétiques
- c Intentionnellement pour des raisons de performances liées à ma pratique sportive
- d Intentionnellement pour respecter une catégorie de poids liée à ma pratique sportive
- e Non intentionnellement, lié à l'augmentation de l'activité physique que mon sport engendre
- f Non intentionnellement, pour toute autre cause (veuillez expliquer la raison dans la réponse Autre)
- g Je ne suis pas concernée
- h Autre : _____

55. A quel âge avez-vous commencé vos variations de poids? *

Merci d'entrer une réponse chiffrée uniquement. Si besoin, la virgule doit être indiquée par un point.

56. Si vous avez définitivement arrêté les variations de poids, depuis combien de temps?

Merci de préciser l'unité (jours, semaines, mois, années).

57. Si vous avez déjà été amenée à arrêter vos variations de poids (que ce soit de façon définitive ou sur une période déterminée), quelles en sont les raisons?

Si les variations de poids ont été arrêtées sur une période donnée, puis reprises, merci de préciser la durée de cet arrêt.

58. Combien de kilos perdez(ou perdiez)-vous en moyenne au cours de vos variations de poids? *

Merci d'entrer une réponse chiffrée uniquement. Si besoin, la virgule doit être indiquée par un point. Répondre en tenant compte des 2 dernières saisons durant lesquelles vous avez réalisé des variations de poids.

VII - Variations de poids

Dans cette partie, vous pourrez décrire vos variations de poids, l'objectif de celles-ci ainsi que les méthodes que vous utilisez pour les réaliser.

Si vous êtes enceinte, merci d'indiquer vos réponses correspondant à la saison sportive précédente.

59. En combien de temps perdez(ou perdiez)-vous ce poids en moyenne? *
- Répondre en tenant compte des 2 dernières saisons durant lesquelles vous avez réalisé des variations de poids.

Une seule réponse possible.

- a une semaine ou moins
- b 1 mois ou moins
- c 3 mois ou moins
- d 6 mois ou moins
- e plus de 6 mois
- f je ne perd(ou perdais) pas de poids

60. Combien de kilos (re)prenez (ou (re)prenez)-vous en moyenne (que ce soit pendant ou après la saison sportive) ? *
- Merci d'entrer une réponse chiffrée uniquement. Si besoin, la virgule doit être indiquée par un point. Répondre en tenant compte des 2 dernières saisons durant lesquelles vous avez réalisé des variations de poids.

61. En combien de temps (re)prenez (ou (re)prenez)-vous ce poids en moyenne? *
- Merci de préciser l'unité (jours, semaines, mois, années). Répondre en tenant compte des 2 dernières saisons durant lesquelles vous avez réalisé des variations de poids.

62. Actuellement, êtes-vous dans une période de... :

Une seule réponse possible.

- a Perte de poids
- b Stabilité pondérale
- c Prise de poids

63. Combien de kilo(s) avez-vous déjà perdu au maximum? *
- Merci d'entrer une réponse chiffrée uniquement. Si besoin, la virgule doit être indiquée par un point.

64. Selon vous, quel serait votre poids idéal (en kg)? *
- Merci d'entrer une réponse chiffrée uniquement. Si besoin, la virgule doit être indiquée par un point.

VIII - Projection sur la(les) future(s) variation(s) de poids

Ici, vous pourrez décrire les variations de poids que vous envisagez de réaliser au cours de la prochaine année : quelles seraient ces variations et comment avez-vous l'intention de vous y prendre.

65. Au cours de l'année à venir, avez-vous l'intention de perdre du poids ? *

Une seule réponse possible.

- a Oui
- b Non
- c Je ne sais pas

66. Si oui, combien de poids voulez-vous perdre (en kg)?
- Merci d'entrer une réponse chiffrée uniquement. Si besoin, la virgule doit être indiquée par un point.

67. Si oui, en combien de temps voulez-vous le perdre?
- Merci de préciser l'unité (jours, semaines, mois, années).

68. Si oui, comment avez-vous l'intention de procéder pour le perdre?

Plusieurs réponses possibles.

Plusieurs réponses possibles.

- a Rééquilibrage alimentaire
- b Restrictions caloriques
- c Restrictions en liquides
- d Augmentation de l'activité physique
- e S'entraîner intentionnellement avec des vêtements épais
- f Saunas
- g Laxatifs
- h Diurétiques
- i Pilules "coupe-faim"
- j Se faire vomir
- k Autre : _____

69. Au cours de l'année à venir, pensez-vous (re)prendre du poids ? *

Une seule réponse possible.

- a Oui intentionnellement
- b Oui non intentionnellement (ex : à l'arrêt d'un régime restrictif, à l'arrêt/diminution de l'activité sportive à la fin de la saison...)
- c Non
- d Je ne sais pas

70. Si oui, combien de poids pensez-vous prendre (en kg)?

Merci d'entrer une réponse chiffrée uniquement. Si besoin, la virgule doit être indiquée par un point.

71. Si oui, en combien de temps pensez-vous le (re)prendre?

Merci de préciser l'unité (jours, semaines, mois, années).

72. Si oui, quelles pourront-être les raisons de cette (re)prise de poids?

Plusieurs réponses possibles.

Plusieurs réponses possibles.

- a Augmentation des quantités ingérées
- b Augmentation des calories ingérées
- c Prise de masse musculaire
- d Prise de masse grasse
- e Réduction de l'activité physique
- f Arrêt d'une contraception
- g Autre : _____

Remarques

Merci pour vos réponses à ce questionnaire !

Nous vous enverrons un rappel dans une semaine par mail afin que vous puissiez à nouveau y répondre.

73. Avez-vous des remarques/commentaires?

PENSEZ A BIEN ENVOYER VOS REPONSES, MERCI ↓

Ce contenu n'est ni rédigé, ni cautionné par Google.

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ANNEXE 4

Questionnaire Answ'her (version traduite en Anglais)

Supplementary material 2 de l'Étude 1, Axe II du manuscrit de thèse.

ANSW'HER QUESTIONNAIRE

This questionnaire is intended for sportswomen aged between 18 and 45 who have been doing sport for at least 2 years and for at least 4 hours a week. Its purpose is to report your hormonal and weight status.

The information you provide will remain strictly confidential.

If you are taking or have taken any contraception, you will be asked for its name(s).

Estimated response time: 15 min.

If you have any questions or comments, there is a dedicated answer at the end of this questionnaire. Alternatively, you can contact us by email at sarah.bagot@uca.fr.

* indicates an mandatory response

Important note:

To advance research on this subject, it is important to answer this questionnaire as calmly and thoroughly as possible.

I - General information

Your personal information will remain strictly confidential

Last name and first name *

E-mail *

1. Country *

2. Age *

Please enter a number only. If necessary, the comma should be indicated by a dot.

3. Height (cm) *

Please enter a number only. If necessary, the comma should be indicated by a dot.

4. Weight (kg) *

Please enter a number only. If necessary, the comma should be indicated by a dot.

5. Have you already had your first period? *

Une seule réponse possible.

Yes

No Go to question 46

6. If not, is there a particular reason?

II - Menstrual cycle and contraception

The purpose of this section is to describe your menstrual cycle and any contraception you are using.

7. How old were you when you first started menstruating? *

Please enter a number only. If necessary, the comma should be indicated by a dot.

8. What is the average length of your menstrual cycle? *

This is the number of days between the first day of the period and the last day before the next period.

One possible answer

- Less than 21 days
- Between 21 and 35 days included
- More than 35 days

9. What is the average length of your period? *

One possible answer

- Less than 4 days
- 4 - 5 days
- 6 days
- More than 6 days

10. When was the first day of your last period? *

Example : 7 January 2016

11. Have your periods ever stopped for more than 3 months (excluding pregnancy)? *

One possible answer

- Yes
- No

12. Over the last 6 months, have your periods been regular (less than 6 days early or late)? *

If you have not had your period in the last 6 months, please select "Other" and, if you can, specify why you have had a break in your period.

One possible answer

- Yes
- No
- Other: _____

13. Have you had late or early periods in the last 3 years (plus or minus 6 days)?

If you had your first period less than 3 years ago, please go on to the next question.

One possible answer

- I haven't had my period in the last 3 years
- Always
- Often
- Sometimes
- Rarely
- Never

14. Are you or have you ever been pregnant? *

Several answers are possible.

- Yes, I am at the moment
- Yes, I have been in the past
- No

15. If yes, how many pregnancies have you had (not including your current pregnancy)?

16. If yes, when was your last pregnancy (not including any current pregnancy)?

17. If you are currently pregnant, how many weeks of amenorrhoea have you reached?

Amenorrhoea is the absence of menstruation. Please enter a number only. If necessary, the comma should be indicated by a dot.

18. Are you currently using contraception? *

One possible answer

- Yes Go to question 19
- No, but I have taken some in the past Go to question 28
- No, I've never taken any Go to question 33

Description of your contraception

19. What method(s) of contraception are you currently using? *

Several possible answers

- Pill
- Hormonal implant
- Copper intrauterin device
- Hormonal intrauterin device
- Contraceptive patch
- Vaginal ring
- Other: _____

20. Specify the name of your contraception(s) *

21. How long have you been using this (these) method(s) of contraception? *

Please specify the unit (days, weeks, months, years).

22. If you are taking the pill, how often do you FORGET to take a tablet? *

Without taking into account the normal stop to induce bleeding or the taking of the placebo tablet.

One possible answer

- Always (more than 7 times per cycle)
- Often (2 to 7 times per cycle)
- Sometimes (1 time per cycle)
- Rarely (1 time every 2 cycles)
- Never (0 time per cycle)

23. In the past, have you used any other method(s) of contraception? *

Several answers are possible.

- Pill
- Hormonal implant
- Copper intrauterin device
- Hormonal intrauterin device
- Contraceptive patch
- Vaginal ring
- I have never taken any other form of contraception
- Other: _____

24. If yes, please give the name of your previous contraceptive(s) and for each, the length of time it was used (in days, months, years)

25. If so, why did you change?

26. If you are taking or have taken the pill, have you ever taken a series of blister packs, or skipped taking a placebo to take a series of blister packs in the case of a continuous pill? *

If you are taking a continuous pill with a placebo, answer 'no'.

One possible answer

- Yes
- No
- I am not concerned

27. If yes, why?

Go to question 33

Your contraceptive history

28. Have you used any of these methods of contraception in the past? *

Several answers are possible

- Pill
- Hormonal implant
- Copper intrauterin device
- Hormonal intrauterin device
- Contraceptive patch
- Vaginal ring
- Other: _____

29. Specify the name of your previous contraceptive(s) and, for each, the length of time it was used (in days, months, years) *

30. For each of them, can you indicate the reason(s) why you stopped? *

31. If you are taking or have taken the pill, have you ever taken a series of blister packs, or skipped taking a placebo to take a series of blister packs in the case of a continuous pill? *

If you are taking a continuous pill with a placebo, answer 'no'.

One possible answer

- Yes
- No
- I am not concerned

32. If yes, why?

III - Current menstrual cycle and associated symptoms

This section will enable you to describe any symptoms you may experience during the different phases of your menstrual cycle, and the measures you have taken to alleviate them.

If you are pregnant, please indicate your answers for your previous menstrual cycles (before pregnancy).

IN THE WEEK BEFORE YOUR PERIOD:

33. In the week before your period, how intense do you usually feel each of the following symptoms on a scale of 0 (not at all) to 5 (very intense)? *

If you do not have periods (excluding pregnancy), please indicate zero for all questions and tick the answer "I am not concerned (absence of periods)" in the next question. If you are pregnant, please indicate your answers for your periods before pregnancy.

One possible answer per ligne

	0	1	2	3	4	5
Increased appetite/hunger	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Decreased appetite	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bloating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hot flushes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Constipation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Abdominal/pelvic pain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Joint pain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Chest pain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Muscle pain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Urges to urinate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fatigue	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Heavy legs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Back pain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Headaches/migraines	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nausea	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Weight loss	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Weight gain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Skin problems/Acne	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mood swings	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dizziness	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

34. If you have any other symptoms during the week before your period not mentioned above, please specify them and rate their intensity from 1 (very mild) to 5 (very strong):

35. Are you able to relieve these symptoms? *

One possible answer

- Yes, totally
- Yes, partially
- No
- I have no symptoms
- I'm not concerned (no periods)
- I don't feel the need

36. If so, how do you go about relieving them?

DURING YOUR PERIOD:

37. During your period, how intense do you usually feel each of the following symptoms on a scale of 0 (not at all) to 5 (very intense)? *

If you do not have periods (excluding pregnancy), please indicate zero for all questions and tick the answer "I am not concerned (absence of periods)" in the next question. If you are pregnant, please indicate your answers for your periods before pregnancy.

One possible answer per ligne

	0	1	2	3	4	5
Increased appetite/hunger	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reduced appetite	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bloating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hot flushes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Constipation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Abdominal/pelvic pain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Joint pain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Chest pain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Muscle pain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Urges to urinate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fatigue	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Heavy legs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Back pain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Headaches/migraines	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nausea	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Weight loss	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Weight gain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Skin problems/Acne	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mood swings	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dizziness	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

38. If you have any other symptoms during your period not mentioned above, please specify them and rate their intensity from 1 (very weak) to 5 (very strong):

39. Are you able to relieve these symptoms? *

One possible answer

- Yes, totally
- Yes, partially
- No
- I have no symptoms
- I'm not concerned (no periods)
- I don't feel the need

40. If yes, how do you go about relieving them?

IV - Menstrual cycle and sporting activity

If you are pregnant, please indicate your answers for your previous menstrual cycles.

41. On the following scale, how does your menstrual cycle affect your sporting activity(ies)? *

One possible answer

- No impact
- Low impact
- Average impact
- Impact fort
- Unable to take part in my sporting activity(ies)

42. On the following scale, how does your menstrual cycle affect your sporting performance? *

One possible answer

- No impact
- Low impact
- Average impact
- Strong impact
- Unable to take part in my sporting activity(ies)

43. If it has an impact, would you describe it as:

One possible answer

- Positive (increased performance)
- Negative (reduced performance)
- Other: _____

44. If you were vaccinated against COVID-19 in 2021, have you noticed any changes in your menstrual cycle? *

One possible answer

- Yes
- No
- I'm not concerned

45. If so, which ones?

V - Sport practice

The purpose of this section is to describe your main sporting activity, i.e. the one you practice most.

If you are pregnant, please indicate your answers for the previous sporting season.

46. What is your main sport? *

47. At what age did you start playing this sport? *

Please enter a number only. If necessary, the comma should be indicated by a dot.

48. How many sessions do you do a week? *

Please enter a number only. If necessary, the comma should be indicated by a dot.

49. What is the average duration of these sessions (in minutes)? *
Please enter a numerical response only.

50. What is the highest level you have reached in competition? *

One possible answer

- I've never competed
- Departmental
- Regional
- National
- International (European or other, on a smaller scale than global)
- Mondial
- Olympic
- Other: _____

51. If you compete or have competed, at what age did you start?
Please enter a number only. If necessary, the comma should be indicated by a dot.

52. When you stopped competing, how old were you?
Please enter a number only. If necessary, the comma should be indicated by a dot.

VI - Body weight management

If you are pregnant, please indicate your answers for the previous sports season.

53. Do you or have you ever INTENTIONALLY OR NON-INTENTIONALLY varied your weight during the sporting season? *

One possible answer

- Yes, I'm still making them Go to question 55
- Yes, but I don't make them any more Go to question 55
- No, but I'm thinking of doing some Go to question 65
- I've never had a weight change (voluntary or involuntary) and I don't intend to (answer "I'm not concerned" to the following question).

54. Have you achieved / are you achieving / would you like to achieve these weight changes? *

Several answers are possible.

- Intentionally for health reasons
- Intentionally for aesthetic reasons
- Intentionally for performance reasons linked to my sporting activities
- Intentionally to comply with a weight category linked to my sporting activities
- Unintentionally, linked to the increased physical activity my sport generates
- Unintentionally, for any other reason (please explain in the Other answer)
- I am not concerned
- Other: _____

VII - Body weight variations

In this section, you can describe your weight changes, the aim of these changes and the methods you use to achieve them.

If you are pregnant, please indicate your answers for the previous sports season.

55. At what age did you start changing your weight? *
Please enter a number only. If necessary, the comma should be indicated by a dot.

56. If you've stopped changing your weight for good, how long have you been doing this?

Please specify the unit (days, weeks, months, years).

57. If you've already had to stop changing your weight (either permanently or over a period of time), what were the reasons?

If weight variations were stopped for a given period and then resumed, please specify the length of time they were stopped.

58. How many kilos have you lost (or were you losing) on average over the course of your weight changes? *

Please enter an encrypted answer only. If necessary, the comma should be indicated by a full stop. Answer taking into account the last 2 seasons during which you have achieved weight variations.

59. How long does (or did) it take you to lose this weight on average? *

Answer taking into account the last 2 seasons during which you have achieved weight variations.

One possible answer

- 1 week or less
- 1 month or less
- 3 months or less
- 6 months or less
- more than 6 months
- I didn't (or didn't) lose weight

60. How many kilos do you (re)gain on average (whether during or after the sporting season)? *

Please enter an encrypted answer only. If necessary, the comma should be indicated by a full stop. Answer taking into account the last 2 seasons during which you have achieved weight variations.

61. How long does it take you to (re)gain this weight on average? *

Please specify the unit (days, weeks, months, years). Answer taking into account the last 2 seasons during which you have achieved weight variations.

62. Are you currently in a period of... :

One possible answer

- Weight loss
- Stable weight
- Weight gain

63. How many kilos have you lost so far? *

Please enter a number only. If necessary, the comma should be indicated by a dot.

64. What do you think your ideal weight would be (in kg)? *

Please enter a number only. If necessary, the comma should be indicated by a dot.

VIII - Projection of future weight change(s)

Here, you can describe the weight changes you plan to make over the next year: what these changes would be and how you intend to go about them.

65. Do you intend to lose weight over the coming year? *

One possible answer

- Yes
- No
- I don't know

66. If so, how much weight do you want to lose (in kg)?

Please enter a number only. If necessary, the comma should be indicated by a dot.

67. If so, how quickly do you want to lose it?

Please specify the unit (days, weeks, months, years).

68. If so, how do you intend to go about losing it?

Several answers are possible.

- Diet rebalancing
- Calorie restrictions
- Liquid restrictions
- Increased physical activity
- Intentionally training in thick clothing
- Saunas
- Laxatives
- Diuretics
- Appetite suppressant pills
- Vomit
- Other: _____

69. Over the coming year, are you thinking of (re)gaining weight? *

One possible answer

- Yes intentionally
- Yes, unintentionally (e.g. stopping a restrictive diet, stopping/diminishing sporting activity at the end of the season, etc.)
- No
- I don't know

70. If yes, how much weight do you expect to gain (in kg)?

Please enter a number only. If necessary, the comma should be indicated by a dot.

71. If yes, how long do you think it will take to (re)take it?

Please specify the unit (days, weeks, months, years).

72. If yes, what could be the reasons for this weight (re)gain?

Several answers are possible.

- Increased food intake
- Increased calorie intake
- Building muscle mass
- Fat mass gain
- Reduced physical activity
- Stopping contraception
- Other: _____

Remarques

Thank you for your answers to this questionnaire!

We'll send you a reminder by e-mail in a week's time so that you can complete it again.

73. Do you have any comments?

DON'T FORGET TO SEND YOUR REPLIES, THANK YOU ↓

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ANNEXE 5

Résultats statistiques « *test-retest-retest* » du questionnaire Answ'Her

Supplementary material 3 de l'Étude 1, Axe II du manuscrit de thèse.

Q33g	qualitative	85						70,6%	0,29	92,2%	0,47	65						67,7%	0,38	90,5%	0,46	65						70,8%	0,42	90,5%	0,48	
Q33h	qualitative	85						58,8%	0,41	87,1%	0,61	65						63,1%	0,51	89,9%	0,72	65						58,5%	0,44	88,0%	0,67	
Q33i	qualitative	85						62,4%	0,20	89,7%	0,37	65						70,8%	0,46	90,8%	0,54	65						61,5%	0,24	88,3%	0,40	
Q33j	qualitative	85						62,4%	0,07	87,5%	0,20	65						70,8%	0,33	89,9%	0,42	65						69,2%	0,20	89,9%	0,42	
Q33k	qualitative	85						41,2%	0,27	81,9%	0,44	65						40,0%	0,24	82,2%	0,43	65						30,8%	0,14	77,5%	0,35	
Q33l	qualitative	85						71,8%	0,42	90,4%	0,51	65						67,7%	0,35	89,2%	0,47	65						56,9%	0,17	84,0%	0,34	
Q33m	qualitative	85						58,8%	0,35	85,2%	0,48	65						55,4%	0,32	85,9%	0,49	65						46,2%	0,19	81,5%	0,33	
Q33n	qualitative	85						70,6%	0,46	91,1%	0,60	65						70,8%	0,47	90,8%	0,62	65						63,1%	0,36	88,6%	0,49	
Q33o	qualitative	85						83,5%	0,42	94,4%	0,53	65						80,0%	0,43	94,2%	0,57	65						80,0%	0,36	93,1%	0,46	
Q33p	qualitative	85						89,4%	0,04	91,2%	0,05	65						92,3%	0,14	94,6%	0,20	65						92,3%	0,02	93,9%	0,02	
Q33q	qualitative	85						55,3%	0,30	87,3%	0,61	65						56,9%	0,37	87,7%	0,62	65						50,8%	0,26	83,4%	0,53	
Q33r	qualitative	85						51,8%	0,40	85,4%	0,59	65						60,0%	0,50	88,6%	0,68	65						44,6%	0,31	81,2%	0,49	
Q33s	qualitative	85						48,2%	0,34	82,8%	0,51	65						52,3%	0,41	86,2%	0,60	65						44,6%	0,32	80,6%	0,47	
Q33t	qualitative	85						85,9%	0,35	96,7%	0,64	65						90,8%	0,59	96,9%	0,69	65						83,1%	0,21	95,1%	0,42	
SCORE PMS	quantitative	85	0,68	[0,56; 0,79]	0,43	2,32						65	0,72	[0,61; 0,83]	-0,35	2,46						65	0,72	[0,61; 0,83]	-0,35	2,46						
Q34	free																															
Q35	qualitative	85						71,8%	0,61	89,4%	0,67	65						72,3%	0,62	89,6%	0,68	65						63,1%	0,48	83,5%	0,48	
Q36	free																															
Q37a	qualitative	85						56,5%	0,44	85,9%	0,60	65						61,5%	0,51	88,3%	0,70	65						49,2%	0,36	83,1%	0,56	
Q37a	qualitative	86						93,0%	0,76	93,0%	0,76	66						95,5%	0,84	95,5%	0,84	66						95,5%	0,85	95,5%	0,85	
Q37b	qualitative	85						80,0%	0,44	94,6%	0,65	65						80,0%	0,45	94,2%	0,65	65						76,9%	0,38	90,8%	0,54	
Q37c	qualitative	85						44,7%	0,31	78,8%	0,47	65						58,5%	0,46	88,3%	0,70	65						44,6%	0,30	81,2%	0,53	
Q37d	qualitative	85						74,1%	0,43	89,9%	0,52	65						75,4%	0,53	92,3%	0,71	65						75,4%	0,50	88,0%	0,49	
Q37e	qualitative	85						75,3%	0,45	90,1%	0,56	65						86,2%	0,67	94,5%	0,71	65						80,0%	0,50	92,0%	0,63	
Q37f	qualitative	85						48,2%	0,38	82,6%	0,55	65						52,3%	0,43	84,6%	0,61	65						30,5%	0,27	82,2%	0,55	
Q37g	qualitative	85						74,1%	0,32	91,5%	0,46	65						69,2%	0,33	91,7%	0,45	65						61,5%	0,20	88,3%	0,34	
Q37h	qualitative	85						58,8%	0,38	86,6%	0,56	65						72,3%	0,61	92,9%	0,79	65						52,3%	0,32	83,7%	0,50	
Q37i	qualitative	85						70,6%	0,37	89,9%	0,45	65						64,6%	0,30	87,7%	0,37	65						55,4%	0,19	86,2%	0,37	
Q37j	qualitative	85						67,1%	0,29	89,9%	0,50	65						72,3%	0,37	90,5%	0,58	65						73,9%	0,38	90,2%	0,57	
Q37k	qualitative	85						41,2%	0,28	82,6%	0,50	65						46,2%	0,34	82,8%	0,52	65						47,7%	0,36	83,4%	0,55	
Q37l	qualitative	85						68,2%	0,31	88,9%	0,45	65						64,6%	0,25	86,5%	0,34	65						72,3%	0,47	88,9%	0,57	
Q37m	qualitative	85						63,5%	0,51	87,8%	0,65	65						60,0%	0,48	87,4%	0,64	65						53,9%	0,40	80,9%	0,49	
Q37n	qualitative	85						63,5%	0,35	88,0%	0,49	65						64,6%	0,44	88,9%	0,58	65						56,9%	0,29	87,1%	0,46	
Q37o	qualitative	85						82,4%	0,38	93,9%	0,50	65						81,5%	0,47	94,6%	0,67	65						80,0%	0,48	93,2%	0,58	
Q37p	qualitative	85						90,6%	0,35	96,1%	0,52	65						89,2%	0,33	96,6%	0,57	65						86,2%	0,21	95,4%	0,45	
Q37q	qualitative	85						61,2%	0,39	88,5%	0,62	65						70,8%	0,56	91,1%	0,73	65						60,0%	0,36	85,2%	0,56	
Q37r	qualitative	85						55,3%	0,42	87,3%	0,62	65						46,2%	0,32	84,9%	0,57	65						40,0%	0,24	80,0%	0,43	
Q37s	qualitative	85						48,2%	0,33	85,7%	0,57	65						44,6%	0,32	84,0%	0,56	65						41,5%	0,27	80,9%	0,48	
Q37t	qualitative	85						85,9%	0,29	94,7%	0,43	65						84,6%	0,28	94,8%	0,37	65						86,2%	0,31	94,8%	0,44	
SCORE MS	quantitative	85	0,73	[0,63; 0,83]	0,37	2,17						65	0,80	[0,72; 0,88]	-0,74	2,97						65	0,64	[0,49; 0,78]	-0,42	2,01						
Q38	free																															
Q39	qualitative	85						71,8%	0,58	91,1%	0,61	65						86,2%	0,79	96,3%	0,82	65						78,5%	0,67	89,6%	0,61	
Q40	free																															
Q41	qualitative	85						55,3%	0,36	83,9%	0,52	65						70,8%	0,59	89,7%	0,69	65						50,8%	0,30	82,6%	0,46	
Q42	qualitative	85						64,7%	0,51	87,5%	0,64	65						72,3%	0,59	90,8%	0,70	65						67,7%	0,53	87,7%	0,61	
Q43	qualitative	85						88,9%	0,65	92,1%	0,67	65						90,7%	0,63	90,7%	0,45	65						84,9%	0,45	88,7%	0,39	
Q44	qualitative	85						91,8%	0,82	95,9%	0,83	65						96,9%	0,92	98,5%	0,93	65						90,8%	0,77	95,4%	0,79	
Q45	free																															
Q46	free																															
Q47	quantitative	86	0,99	[0,99; 1,00]	-0,12	0,99						66	0,99	[0,99; 1,00]	-0,03	0,89						66	0,99	[0,99; 1,00]	-0,14	0,94						
Q48	quantitative	86	0,91	[0,87; 0,95]	0,12	0,82						66	0,92	[0,88; 0,96]	-0,01	0,81						66	0,85	[0,79; 0,92]	0,12	1,07						
Q49	quantitative	86	0,62	[0,50; 0,75]	0,76	20,96						66	0,68	[0,55; 0,81]	-2,73	23,71						66	0,49	[0,33; 0,66]	-0,38	26,79						
Q50	qualitative	86						86,1%	0,80	95,8%	0,82	66						90,9%	0,86	97,3%	0,88	66						83,3%	0,75	96,4%	0,84	
Q51	quantitative	77	0,92	[0,89; 0,96]	-0,25	2,58						61	0,98	[0,97; 0,99]	0,16	1,41						59	0,91	[0,87; 0,95]	-0,15	3,00						
Q52	quantitative	10	0,98	[0,96; 1,00]	0,00	0,67						6	0,97	[0,92; 1,02]	0,00	0,89						5	0,94	[0,88; 1,01]	0,20	1,10						
Q53	qualitative	86						76,7%	0,66	87,6%	0,72	66						87,9%	0,82	92,4%	0,83	66						77,3%	0,66	85,9%	0,69	
Q54b	qualitative	86						94,2%	0,26	94,2%	0,26	66						97,0%	0,65	97,0%	0,65	66						90,9%	0,05	90,9%	0,05	
Q54c	qualitative	86						82,6%	0,57	82,6%	0,57	66						80,3%	0,53	80,3%	0,53	66						80,3%	0,54	80,3%	0,54	
Q54d	qualitative	86						100,0%	1,00	100,0%	1,00	66						98,5%	0,95	98,5%	0,95	66						98,5%	0,95	98,5%	0,85	
Q54e	qualitative	86						82,6%	0,65	82,6%	0,65	66						84,9%	0,70	84,9%	0,70	66						81,8%	0,64	81,8%	0,64	
Q54f	qualitative	86			</																											

