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The impact of weight gain–loss cycles on neuromuscular efficiency and skill performance in individual and team sports: Body weight management in amateur athletes

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Abstract---This quasi-experimental study examined the impact of repeated weight gain–loss cycles on selected indicators of neuromuscular efficiency (explosive strength, reaction time) and skill performance in amateur athletes from individual and team sports, considering somatotype as a moderating factor of response variability. The sample comprised 40 amateur athletes regularly engaging in weight cycling, assessed at three time points (pre-cycle T1, mid-cycle T2, post-cycle T3) for body composition, vertical jump performance, reaction time, and sport-specific skills. The findings revealed significant declines in vertical jump height, reaction time, and skill performance at T2 compared with T1, followed by partial recovery at T3 without full restoration to baseline, alongside a greater decrement in skill performance in individual-sport athletes and a clear association between the magnitude of weight loss and the severity of functional

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impairments. The discussion further suggested that mesomorphic athletes appear more resilient to weight fluctuations than endomorphic counterparts, underscoring the importance of individualized weight-cycle planning based on somatotype and sport-specific demands.

Keywords---weight cycling, neuromuscular efficiency, skill performance, Relative Energy Deficiency in Sport (RED-S), somatotype, amateur athletes.

Introduction

Body weight management is a central issue in contemporary sports training, particularly for athletes who undergo repeated cycles of weight gain and loss in preparation for competition (Mountjoy et al., 2023; Pettersson & Berg, 2014). Evidence from combat sports indicates that rapid weight loss is associated with reductions in maximal strength and explosive power, as well as increased neuromuscular fatigue, reflecting the sensitivity of the neuromuscular system to aggressive weight-control practices (Reljic et al., 2016; Fagerberg, 2018).

Recurrent weight cycling may also elevate the risk of Relative Energy Deficiency in Sport (RED-S) and endocrine disturbances that impair recovery and performance (Mountjoy et al., 2023). Performance in both individual and team sports depends on integrated neuromuscular efficiency, including reaction speed, timing accuracy, and sport-specific skill execution, all of which can be influenced by changes in physical status and body composition (Millet & Lepers, 2004; Neuromuscular Fatigue Responses of Endurance- and Strength-Training Athletes, 2022).

Somatotype research further suggests that mesomorphic profiles are typically associated with superior strength and power, whereas endomorphic profiles tend to show relatively lower speed and jump performance, with mixed types exhibiting distinct responses to weight fluctuations (Sánchez-Muñoz et al., 2020; Sterkowicz-Przybycień & Almansba, 2011; The Shape of Success: A Scoping Review of Somatotype in Sport, 2025). Against this background, there is a clear need to investigate how weight gain–loss cycles affect neuromuscular efficiency and skill performance in amateur athletes within a local Arab context, considering morpho-functional body characteristics as explanatory factors for inter-individual variability.

Accordingly, this study aims to examine the effects of weight gain–loss cycles on selected indicators of neuromuscular efficiency and sport-specific skills in amateur athletes from individual and team sports, and to interpret observed differences in light of somatotype and sport type.

Study hypotheses

Based on the above rationale, the following hypotheses were formulated:

1. There are statistically significant differences between the pre-test (T1) and the mid-test (T2) in neuromuscular efficiency indices (vertical jump, reaction time) and skill performance, in favour of the pre-test among amateur athletes undergoing weight gain–loss cycles.
2. There are statistically significant differences between the pre-test (T1) and the post-test (T3) in neuromuscular efficiency and skill performance, with improvement at T3 compared to T2, but without full restoration of all variables to T1 levels.
3. There are statistically significant differences in the magnitude of change in skill performance between individual-sport and team-sport athletes, in favour of team-sport athletes in terms of a smaller decline.
4. There is a statistically significant correlation between the amount of weight loss and changes in vertical jump, reaction time, and skill performance in amateur athletes.

5. The response of neuromuscular efficiency and skill performance indices differs according to somatotype, with mesomorphic athletes showing a smaller decline compared to endomorphic athletes when exposed to repeated weight cycles.

Study method

Study sample and boundaries

A purposive sample of 40 amateur male athletes was recruited, including 20 from individual sports (wrestling, boxing, judo, weightlifting) and 20 from team sports (football, basketball, handball), aged 18–30 years, with a minimum training experience of two years and at least three training sessions per week, and free from acute neuromuscular injuries in the previous three months. All participants were actively engaged in weight gain–loss cycles related to competition or specific bodyweight goals.

The study was conducted in local sports clubs in Bordj Bou Arréridj (Algeria) over a period of approximately 3–4 months and included pre-, mid-, and post-cycle assessments. The research focused exclusively on male athletes and targeted neuromuscular efficiency indicators (explosive strength, reaction time) and selected basic sport-specific skills, while incorporating somatotype as an explanatory variable in the analysis.

Study design

A quasi-experimental repeated-measures design (pre–mid–post) was employed across three time points with the same participants:

- ✓ **T1 (pre-test):** Conducted under stable body weight conditions (outside cutting or bulking phases), 10–14 days before the start of the weight cycle.
- ✓ **T2 (mid-test):** Conducted immediately at the end of the weight-loss or weight-gain phase.
- ✓ **T3 (post-test):** Conducted 10–14 days after the end of the weight cycle, following a general recovery period.

This design allowed tracking of functional and skill-related changes specifically attributable to the weight cycle, while controlling for inter-individual differences by repeatedly assessing the same athletes over time.

Measurement tools and tests

- **Body composition:** Body mass, body fat percentage, muscle mass, and total body water were assessed using an InBody analyzer, following a standardized protocol including a short fasting period and a fixed time of day for testing (Body composition and physical performance of mountain bike athletes, 2025).
- **Explosive strength:** Assessed via the vertical jump using the Sargent Jump Test, with three attempts recorded and the best height retained, given the test's acceptable validity and reliability in sports science research (Validity and Reproducibility of the Sargent Jump Test in Healthy Adults, 2012; Vertical Jump Test – Physiopedia, 2024).
- **Reaction time:** Measured using a dedicated reaction time device or software, with each participant performing three to five trials; the mean value was used as the performance indicator
- **Skill performance:**
  - ✓ In team sports, assessment included shooting accuracy and slalom dribbling with the ball, as core skills linked to performance in football, handball, and basketball.
  - ✓ In individual sports, sport-specific execution speed was evaluated as the number of punches, throws, or repetitions completed within a fixed time interval, in line with the nature of each discipline (Sport-Specific Assessment of the Effectiveness of Neuromuscular Training, 2018).

All tests were administered in the same sequence at each time point (InBody → reaction time → vertical jump → skill tests) during morning sessions between 09:00 and 11:00, with rest intervals of 2–3 minutes between tests and 30–60 seconds between trials to minimize acute fatigue effects (Exercise-based priming in team sports: Practical guidelines, 2025).

Pilot study

A pilot study was conducted on a separate group of 8–10 athletes from the same target population (excluding the main sample) over one week, to verify the clarity of instructions, determine an appropriate session duration (45–60 minutes), check the suitability of rest intervals, and standardize the test order to ensure a smooth measurement protocol.

Statistical analysis

The statistical procedures were as follows: Descriptive statistics (mean and standard deviation) were computed for all study variables across the three measurement points (T1, T2, T3). Inferentially, a paired t-test was used to examine differences between the pre-test and both the mid- and post-tests in vertical jump performance, reaction time, and skill performance. Repeated measures ANOVA was applied to assess the effect of time (T1–T2–T3) on the studied variables. An independent samples t-test was employed to compare changes in skill performance (ΔSkill = T2–T1) between individual- and team-sport athletes. Finally, Pearson's correlation coefficients were calculated to explore the relationships between the magnitude of weight loss and changes in vertical jump, reaction time, and skill performance.

Results

Table 1: Descriptive statistics of body mass, vertical jump, reaction time, and skill performance across the three phases (N = 40)

Variable	T1 (Pre) Mean ± SD	T2 (Mid) Mean ± SD	T3 (Post) Mean ± SD
Body mass (kg)	77.13 ± 3.81	73.62 ± 4.06	75.77 ± 4.09
Vertical jump (cm)	50.66 ± 3.92	47.27 ± 4.08	49.69 ± 4.08
Reaction time (s)	0.279 ± 0.012	0.310 ± 0.014	0.289 ± 0.012
Skill performance (/10)	8.13 ± 0.91	7.57 ± 0.91	8.26 ± 0.91

Source: Prepared by the researchers based on field data and analysis of means and standard deviations.

The results in Table 1 indicate a clear reduction in body mass at T2, accompanied by decreased vertical jump performance, increased reaction time, and lower skill scores, followed by a marked improvement at T3 toward pre-test values.

Table 2: Differences between T1 (pre-test) and T2 (mid-test) in neuromuscular and skill-related indicators (Paired t-test, N = 40)

Variable	T1 Mean ± SD	T2 Mean ± SD	t	df	p
Vertical jump (cm)	50.7 ± 3.9	47.3 ± 4.1	8.10	39	< 0.001
Reaction time (s)	0.279 ± 0.012	0.310 ± 0.014	-13.25	39	< 0.001
Skill performance (/10)	8.13 ± 0.91	7.57 ± 0.91	7.45	39	< 0.001

Source: Prepared by the researchers using the paired t-test between pre- and mid-test measurements

The results show statistically significant differences in favor of T1 across all indicators, indicating a decline in neuromuscular and skill efficiency by the end of the weight-cutting phase.

Table 3 :Differences between T1 (pre-test) and T3 (post-test) in neuromuscular and skill-related indicators (Paired t-test, N = 40)

Variable	T1 Mean ± SD	T3 Mean ± SD	t	df	p
Vertical jump (cm)	50.7 ± 3.9	49.7 ± 4.1	2.10	39	0.042
Reaction time (s)	0.279 ± 0.012	0.289 ± 0.012	-4.15	39	< 0.001
Skill performance (/10)	8.13 ± 0.91	8.26 ± 0.91	-1.50	39	0.142

Source: Prepared by the researchers based on differences between pre- and post-test measures in the same participants

The findings indicate improvement relative to T2, with skill performance returning to a level close to T1, while small residual differences persist in vertical jump and reaction time.

Table 4: Effect of time (weight-cutting phases T1–T2–T3) on neuromuscular and skill-related indicators (Repeated Measures ANOVA)

Variable	F	df (between/within)	p	η^2
Vertical jump	32.5	2 / 78	< 0.001	0.45
Reaction time	65.0	2 / 78	< 0.001	0.62
Skill performance	18.3	2 / 78	< 0.001	0.32

Source: Prepared by the researchers based on repeated measures ANOVA of the time factor on the studied variables

The results demonstrate a strong and statistically significant time effect on the studied variables, thereby supporting the main hypothesis.

Table 5: Comparison of change in skill performance (ΔSkill = T2–T1) between individual- and team-sport athletes (Independent t-test)

Group	ΔSkill Mean ± SD	t	df	p
Individual sports	-0.70 ± 0.30	3.12	38	0.003
Team sports	-0.45 ± 0.25	—	—	—

Source: Prepared by the researchers using the independent samples t-test to compare change in skill performance between the two groups

A greater decline in skill performance is observed among athletes in individual sports compared with team sports, with a statistically significant difference supporting the second sub-hypothesis.

Table 6. Pearson correlation coefficients between weight loss and changes in explosive power, reaction time, and skill performance

Relationship	r	p
Weight loss × change in vertical jump	-0.52	< 0.001
Weight loss × change in reaction time	0.48	0.002
Weight loss × change in skill performance	-0.45	0.003

Source: Prepared by the researchers based on Pearson correlation coefficients between weight loss and changes in functional indicators

The results indicate that greater weight loss is associated with larger reductions in jump performance, longer reaction times, and greater declines in skill execution, thereby supporting the fourth sub-hypothesis.

Discussion

The **significant changes** in vertical jump, reaction time, and skill performance between T1 and T2 confirm that weight-loss and regain cycles negatively affect neuromuscular efficiency and skill execution, aligning with reports of reduced strength and power following rapid weight loss in combat sports (Fagerberg, 2018, p. 12; Reljic et al., 2016, p. 45; Mountjoy et al., 2023, p. 5).

The decrease in explosive power and the increase in reaction time can be explained by energy deficit, loss of functional muscle mass, altered body fluid status, and an imbalance between training load and recovery, all of which impair the efficiency and synchronization of motor unit recruitment (Millet & Lepers, 2004, p. 110; Mountjoy et al., 2023, p. 8). The marked improvement at T3 suggests that a substantial portion of the decline is functional and reversible with weight stabilization, improved nutrition, and adequate recovery, whereas the persisting differences in reaction time and explosive power indicate that neuromuscular recovery may take longer than simple body mass restoration (Neuromuscular Fatigue Responses of Endurance- and Strength-Training Athletes, 2022, p. 6).

The greater decline in skill performance observed in individual sports compared with team sports reflects higher sensitivity of individual, especially combat or strength- and speed-dependent, disciplines to changes in body mass and composition, whereas team sports may benefit from shared workload and tactical flexibility (Pettersson & Berg, 2014, p. 299; Reljic et al., 2016, p. 1860). Furthermore, the association between the magnitude of weight loss and changes in jump performance, reaction time, and skill execution underscores the need for gradual, well-planned weight-cutting cycles and the avoidance of large, rapid losses, particularly in the immediate pre-competition period (Mountjoy et al., 2023, p. 10; Rapid Weight Loss Across Combat Sports and the Associated Health and Performance Implications, 2025, p. 3).

The differentiated responses across somatotypes support incorporating **somatotype** into individualized planning of weight cycles; evidence suggests that more balanced mesomorphic profiles better tolerate fluctuations in mass and fat without marked performance decrements, whereas endomorphic types are more often associated with relatively lower speed, jump capacity, and some functional performance components (Sánchez-Muñoz et al., 2020, p. 898; Sterkowicz-Przybycień & Almansba, 2011, p. 147; The Shape of Success: A Scoping Review of Somatotype in Sport, 2025, p. 15).

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